# Temporary Seeding and Stabilization

## Definition

The MPCA Construction General Permit defines stabilization, stabilized, and stabilize as meaning that “the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring. Grass, agricultural crop or other seeding alone is not stabilization.”

Stabilization includes a wide range of erosion prevention practices that cover exposed soil such as the use of straw, mulch, erosion control blankets, plastic sheeting or tarpaulins. Temporary seeding is a soil stabilization practice involving the establishment of temporary vegetative cover to reduce erosion on construction sites that have disturbed areas that are temporarily idle (i.e., where no soil disturbing activities occur on that portion of the site for 14 or more consecutive days). Erosion prevention practices like stabilization are generally less costly and more effective than sediment control measures, which involve settling or filtering mobilized soil particles before they are transported by runoff to surface waters.

## Purpose and Function

Temporary seeding and stabilization are intended to counteract the erosive influences of rainfall, rain and snowmelt runoff, and wind on bare soil. Stabilization prevents the mobilization and subsequent transport of soil particles by preventing erosion. Stabilization practices, which mostly include temporary vegetated cover and the application of a mulch, blanket, mat, or other cover on bare soil, is the easiest, cheapest, and most effective approach for addressing sediment loss (muddy runoff and dust) from construction sites. Since temporary seeding is only effective for erosion control once vegetation has established, mulch or other temporary cover is needed to protect seeded areas until vegetation emerges. A good stand of vegetation will protect soil from erosion by raindrop impact and help slow runoff to prevent rill erosion. The vegetation can also act as a filter, trapping coarse sediment particles carried by runoff.

## Applicability

Temporary seeding and stabilization apply to areas of construction sites where soil-disturbing activities have temporarily ceased, and/or immediate measures are needed to prevent erosion and sediment runoff at its source during anticipated rainfall or snowmelt events. *Note: Temporary seeding information is presented in this subsection; information on other approaches for temporary stabilization (e.g., blankets, mats, mulches, hydraulically applied products, etc.) can be found in other subsections.*

### 1.3.1 Site Applicability

Construction sites often have areas where soil disturbing activities such as clearing, grading, or cut/fill work has stopped for a period of time. Bare areas that are not actively under construction need some type of temporary cover to prevent or minimize erosion in the event of rainfall or snowmelt. Applicable areas include topsoil stockpiles, rough graded areas, sediment basin dikes, ditches, temporary earthen structures, and graded areas undergoing settlement.

### 1.3.2 Permit Applicability

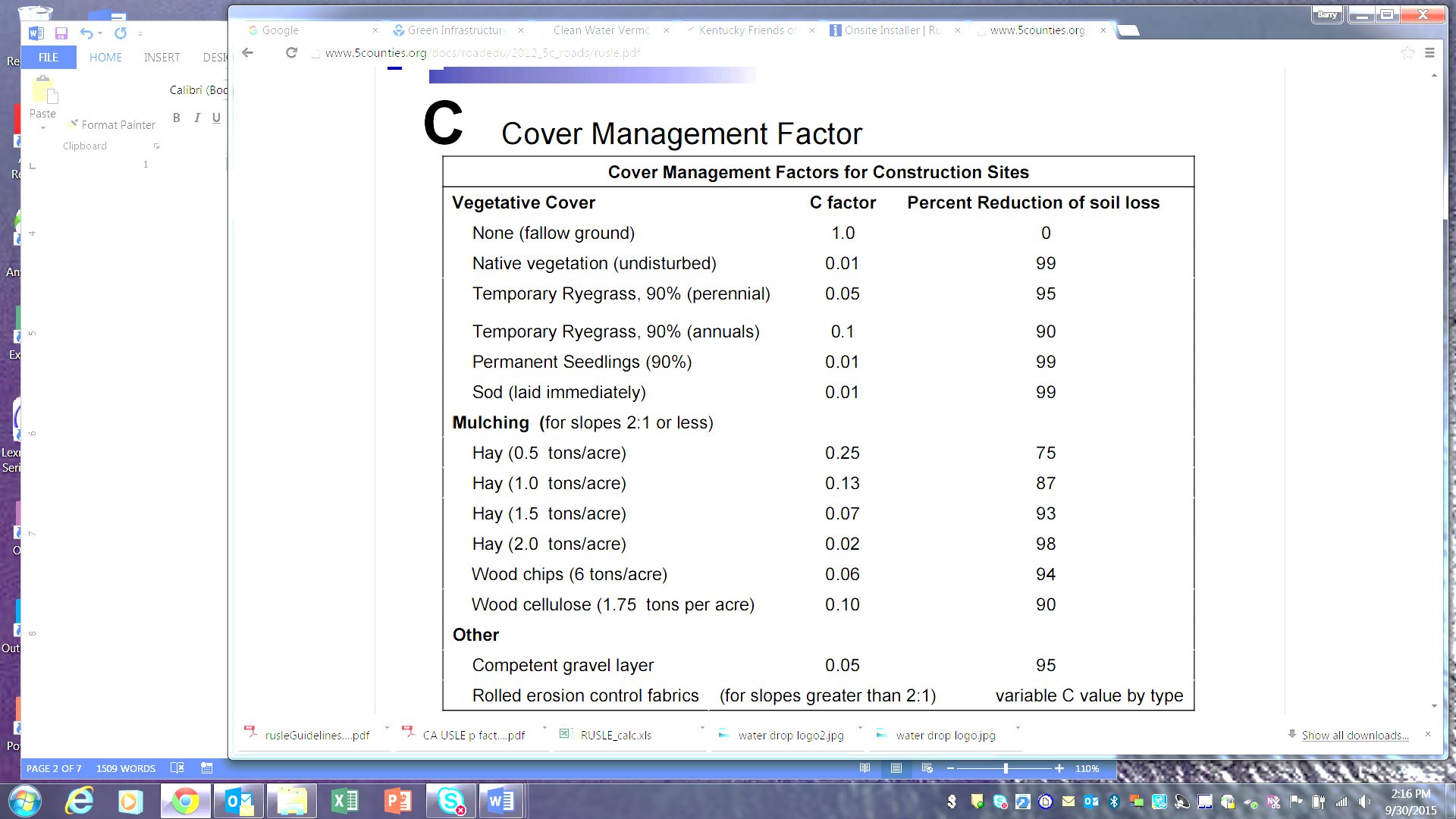
The MPCA Construction General Permit has several requirements regarding temporary stabilization.

* [Part IV.B.2](http://stormwater.pca.state.mn.us/index.php/IV._CONSTRUCTION_ACTIVITY_REQUIREMENTS#IV.B_EROSION_PREVENTION_PRACTICES) of the 2013 MPCA Construction Stormwater General Permit states that the permittee(s) “must stabilize all exposed soil areas (including stockpiles). Stabilization must be initiated immediately to limit soil erosion whenever any construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days.” In addition, “(s)tabilization must be completed no later than 14 calendar days after the construction activity in that portion of the site has temporarily or permanently ceased.”
* Near public waters that the Minnesota DNR has promulgated “work in water restrictions” during specified fish spawning time frames, per [Part IV.B.2](http://stormwater.pca.state.mn.us/index.php/IV._CONSTRUCTION_ACTIVITY_REQUIREMENTS#IV.B_EROSION_PREVENTION_PRACTICES), “all exposed soil areas that are within 200 feet of the water’s edge, and drain to these waters must complete the stabilization activities within 24 hours during the restriction period. Temporary stockpiles without significant silt, clay or organic components (e.g., clean aggregate stockpiles, demolition concrete stockpiles, sand stockpiles) and the constructed base components of roads, parking lots and similar surfaces are exempt from this requirement.”
* Other permit requirements exist during the construction of post-construction/permanent stormwater and temperature control BMPs discharging to special waters and impaired waters. In those cases, [Appendix A Section C.1](http://stormwater.pca.state.mn.us/index.php/APPENDIX_A) of the 2013 MPCA Construction Stormwater General Permit requires that “(s)tabilization of all exposed soil areas must be initiated immediately to limit soil erosion but in no case completed later than seven (7) days after the construction activity in that portion of the site has temporarily or permanently ceased.”
* Finally, it shall be noted that stabilization requires more than seed alone. [Appendix B Section 26](http://stormwater.pca.state.mn.us/index.php/APPENDIX_B_-_DEFINITIONS) of the 2013 MPCA Construction Stormwater General Permit defines stabilization as “the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring. Grass, agricultural crop or other seeding alone is not stabilization. Mulch materials must achieve approximately 90 percent ground coverage (typically 2 ton/acre).”

## Effectiveness

Temporary seeding and stabilization is effective in reducing soil loss from construction sites once vegetation has become established (Table 1‑1).Vegetative cover can reduce erosion by up to 99 percent, with the application of mulch at the MPCA recommended rate of two tons per acre achieving similar results. Because seeding is only effective after plants have emerged, the application of straw mulch or other cover is required at the time of seeding. Erosion prevention practices such as seeding and mulching are generally more effective and less expensive than sediment control practices.

Table 1‑1. Bare soil cover types and percent reduction of soil loss



Source: Northwest California Resource Conservation and Development District 2016

Table 1‑2 summarizes expected performance for an array of typical water quantity and quality target constituents for temporary seeding and stabilization practices. Once established, a good stand of vegetation will protect soil from erosion by raindrop impact and help slow runoff to prevent rill erosion. The vegetation can also act as a filter, trapping coarse sediment particles (and associated pollutants, including nutrients and some heavy metals) carried by runoff.

Table 1‑2. Expected performance for temporary seeding and stabilization practices

|  |  |
| --- | --- |
| **Water Quantity** | |
| Flow attenuation | ○ |
| Runoff volume reduction | ◖ |
| **Water Quality** | |
| **Pollution prevention** | |
| Soil erosion | ● |
| Sediment control | ◖ |
| Nutrient loading | ● |
| **Pollutant removal** | |
| Total suspended solids | ● |
| Total phosphorus | ● |
| Heavy metals | ◖ |
| Floatables | ○ |
| Oil and grease | ○ |

● Primary design benefit

◖ Secondary design benefit

○ Little or no design benefit

## Planning Considerations

Erosion prevention through soil stabilization is always preferred over sediment control, due to cost and overall effectiveness considerations. However, because of the nature of the work, erosion prevention is not always feasible on active construction sites. When a disturbed area will be inactive for a prolonged period, erosion prevention measures are typically required. Areas left un-disturbed over the winter should also be temporarily seeded and stabilized.

Temporary seeding is an effective erosion prevention practice that primarily uses the quick emergence of annual seedlings to stabilize bare soil surfaces. As such, proper seedbed preparation and the use of quality seed are important for good germination and growth. A poor stand (less than 50 percent cover) will not provide adequate erosion prevention.

A key planning objective involves the minimization of bare soil footprints at the site, followed by the immediate stabilization of inactive areas through temporary seeding or other measures until the next phase of construction begins. Planning and staging projects in a manner that minimizes the extent and duration of soil disturbance helps to reduce both erosion and sediment loss. In practice, this often means scheduling operations to complete clearing, grading, and cut/fill operations in a phased manner, so that disturbed areas can manageably be stabilized (either temporarily or permanently)as the project proceeds. Planning approach examples include:

* Subdivision development – complete clearing, grading, and primary road layout, then temporarily seed and mulch home site and secondary road locations until construction begins in those areas.
* Commercial projects – immediately seed and mulch graded building footprint(s) and proposed landscaped areas, then focus construction and material storage on areas immediately adjacent to the building pad(s). Parking lots can be graveled and used for material storage, staging, and parking.
* Institutional and manufacturing facilities – same as commercial projects. Keep activities close to the vertical construction site, minimize disturbed areas, and temporarily seed idle areas.

Outside contractors are not typically required for temporary seeding and stabilization. Keeping the specified seed, straw mulch, rolled erosion control products, and other materials on hand ensures that temporary seeding is implemented timely and efficiently. High priority areas for immediate stabilization include areas within 100 feet of a lake, river, stream, or wetland; slopes steeper than 4H:1V; and ditches and channels within 200 feet of a waterbody or property line.

The current list of MnDOT certified/approved vendors for seed are available on the MnDOT website:

<http://www.dot.state.mn.us/environment/erosion/certifiedvendors.html>

## Design

Key design parameters for temporary seeding include: 1) the desired length of time for stabilization; 2) the appropriate type of seed or seed mix; 3) the rate of seed application; 4) the time of year in which the seed is planted; and 5) the type of mulch, blanket, or other material used to cover the site and support the emergent vegetation. In addition:

* Select a seed type or mix appropriate for the length of time that temporary stabilization is needed. Seeds labeled annual will die off at the end of the growing season and must be re-seeded to maintain vegetative cover afterwards. Perennial seeds will result in grass that persists for many growing seasons, and should be used where temporary cover is needed beyond the late fall and winter periods. Annual seed is often planted in combination with perennial seed to provide quick stabilization and help establish the longer-maturing plants.
* Select seeds that sprout quickly and are effective and economical in providing temporary cover (see Table 1‑3 for MnDOT’s seed mixtures).
* Calibrate the seed application rate on the type of terrain to be seeded. For example, steep slopes, buffers next to surface waters, and flow channels require a denser stand of grass than flat areas.
* Straw mulch applied at two tons per acre is typically used to provide immediate cover and support emerging grass, although erosion control blankets and other options are available depending on site conditions.

Table 1‑3. Seed mixture selection and other information for various construction site stabilization periods

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Seed/Mixture Name and**  **Planting Season** | **MnDOT**  **Mixture #** | **Common**  **Name** | **Scientific Name** | **Rate (lb/acre)** | **% of Mix  (by weight)** |
| Oats One Year Cover Crop  May 1 – August 1 | 21-111 | Oats | *Avena sativa* | 100.00 | 100.00% |
|  | *Total* | *100.00* | *100.00%* |
|  |  |  |  |  |  |
| Winter Wheat One Year Cover Crop  August 1 – October 1 | 21-112 | Winter Wheat | *Triticum aestivum* | 100.00 | 100.00% |
|  | *Total* | *100.00* | *100.00%* |
|  |  |  |  |  |  |
| Soil Building One Year Cover Crop  May 1 – August 1 | 21-113 | Field Pea | *Pisum sativum* | 50.00 | 45.46% |
| Oats | *Avena sativa* | 60.00 | 54.54% |
|  | *Total* | *110.00* | *100.00%* |
|  |  |  |  |  |  |
| One to Two Year Stabilization  April 1 – July 20  July 20 – October 20 | 22-111 | Slender Wheatgrass | *Elymus trachycaulus* | 9.00 | 29.50% |
| Perennial Ryegrass | *Lolium perenne* | 4.50 | 14.76% |
| Alfalfa | *Medicago sativa* | 8.50 | 27.86% |
| Red Clover | *Trifolium pratense* | 8.50 | 27.88% |
|  | *Total* | *30.50* | *100.00%* |
|  |  |  |  |  |  |
| Two to Five Year Stabilization  April 1 – July 20  July 20 – October 20 | 22-112 | Perennial Ryegrass | *Lolium perenne* | 13.50 | 33.75% |
| Smooth Brome | *Bromus inermis* | 6.00 | 14.99% |
| Slender Wheatgrass | *Elymus trachycaulus* | 2.00 | 5.01% |
| Big Bluestem | *Andropogon gerardii* | 0.50 | 1.25% |
| Alfalfa | *Medicago sativa* | 8.50 | 21.25% |
| Red Clover | *Trifolium pratense* | 5.50 | 13.74% |
| Alsike Clover | *Trifolium hybridum* | 3.50 | 8.75% |
| American Vetch | *Vicia americana* | 0.50 | 1.26% |
|  | *Total* | *40.00* | *100.00%* |

*Source: MnDOT Seeding Manual, 2014 Edition, Office of Environmental Stewardship Erosion Control Engineering Unit. Note: For the portion of Minnesota north of and including US Highway 2, the seeding season for mixtures 22-111 and 22-112 is April 15 through September 20.*

* After selecting the appropriate type of seed (see Table 1‑3), prepare the seedbed by tilling to a minimum depth of 3 inches. In compacted or hard soils, it may be necessary to use a disc, ripper or other relatively heavy tillage equipment to help prepare the seedbed. On sloped sites, all equipment activities (including disking, ripping, or tilling) should be performed by across the contour (versus up and down slope) to help minimize rill erosion. Where large soil clods are present, rolling or cultipacking may be required before seeding to ensure uniform seeding depths and good seed/soil contact. Do not prepare areas for seeding under excessively wet conditions.
* If a soil test confirms a need for fertilizer or liming, apply the recommended amount and incorporate it into the top 2 to 4 inches of soil during seedbed preparation. Use a slow-release fertilizer to minimize the chance for nutrient runoff into surface waters. Test for presence of agricultural chemicals (e.g., herbicides, pesticides) if using topsoil from farmland; methods may include conducting bioassays or sending samples to a laboratory for chemical analysis (e.g., EPA methods for laboratory analysis of soil samples include EPA Methods 8081 and 8141 for pesticides and EPA Method 8151 for herbicides).
* Check seed distribution equipment on a smaller test area of known dimensions prior to seeding the site by comparing weight of seed dropped/broadcast versus the test area covered, and calibrate if necessary. Apply seed evenly with a cyclone seeder, drill, cultipacker seeder, or with a hydroseeder. Small grains and grasses should be planted no more than 0.5 inch deep.
* Consider seeding at a lower rate and making two passes to ensure adequate coverage. Do not seed when conditions are wet. Use a cultipacker or other roller to lightly but firmly press soil around seed.

Table 1‑4. Summary of seeding methods and related information for temporary stabilization

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Method** | **Site Applications** | **Site Preparation** | **Equipment** | **Mulch Type** |
| Drop seeding | Prepared seed beds | Loosen topsoil to a depth of at least 3 inches; leave rough | Drop seeder, followed by cultipacker | Punched-in straw; erosion blanket |
| Broadcast seeding | Prepared seed beds | Loosen topsoil to a depth of at least 3 inches; leave rough | Mechanical cyclone attachment or hand seeder | Punched-in straw; erosion blanket |
| Hydroseeding | Steep slopes and other inaccessible areas; wetland and pond edges | Loosen topsoil to a depth of at least 3 inches; leave rough; avoid hot and dry conditions | Hydroseeder with fan-type nozzle; 500 gallons of water per acre | Bonded fiber matrix; cellulose hydromulch; punched-in straw |
| Inter-seeding | Poorly / sparsely vegetated areas; areas of poor past seeding/germination | Mow existing vegetation; kill broadleaf weeds | Inter-seeding drill with trash ripper, followed by cultipacker | Not required, but recommended for steeper slopes |

Source: Adapted from MnDOT Seeding Manual 2014

* Cover slopes steeper than 3H:1V with an erosion control blanket. If seeding is being done in a temporary ditch or swale that will receive moderate water flows during the stabilization period, it is recommended that a straw/coconut blanket be used to cover the seed. Other more severe situations such as very steep slopes and/or channels exposed to high water velocities will require more specialized treatments.
* In general, slopes that are 3H:1V and flatter should be mulched with a clean grain straw or native grass mulch and disc anchored following seeding. Mulching should attempt to achieve 90 percent or greater coverage of the exposed soil surface. This generally requires about 2 tons per acre of straw mulch. If possible, use a high quality weed free mulch such as [MCIA Certified Weed Free](http://www.mncia.org/noxious-weed-seed-free-forage-mulch) mulch or a native prairie grass mulch.
* For areas seeded during the dormant period (i.e., when soils are too cold for germination), broadcast seed after soil temperature at a depth of one inch below the surface are at or below 40 degrees. Different species of grasses will be dormant at different times of the year and will not germinate. Forbs should be installed in the fall, because they need to go through a freeze/thaw cycle prior to germination. Where erosion or wind is a concern, cover seeded areas with mulch or blankets if possible; plan to interseed (i.e., with an interseeding drill) in the spring.
* Mark off and post signs around seeded areas to keep vehicles, equipment, livestock, and foot traffic away. Provide alternative traffic routes and parking to ensure seeded area remains protected.

## Standards and Specifications

MnDOT Specification 2575.3 parts A and B (pages 502 to 504) include guidance for temporary seeding, including seeding dates for various MnDOT seed mixtures (as shown in Table 1‑3), site conditions requiring temporary seeding, and application methods. Part K.3, which covers maintenance of seeded areas, states: *“Repair damage within the area caused by Contractor operations and within the Contractor‘s control at no expense to the Department. Reseed areas where the original seed has failed to grow, as directed by the Engineer.”*

Specification 2575.4 (pages 510, 511) prescribes requirements for measurement of seed and seeding. Seed should meet Specification 3876 (“Seed”; pages 666-669). Table 3876-1 prescribes standard seed mixes and pure live seed (PLS) application rates (lb/acre, as summarized in Table 1‑3). The 2016 edition of the MnDOT *Standard Specifications for Construction* can be found here: <http://www.dot.state.mn.us/pre-letting/spec/> (See <http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf>, page 502.)

## Inspection and Maintenance

Inspect areas immediately prior to seeding to ensure that the seedbed is properly tilled (i.e., down to at least 3 inches), roughened so that seed can fall into the spaces between the soil particles, and free of large rocks, woody debris, litter, etc. Inspect again immediately after seeding and mulching for proper coverage and cultipacker (or other roller) results. The seedbed should be lightly compacted, to maximize seed-to-soil contact.

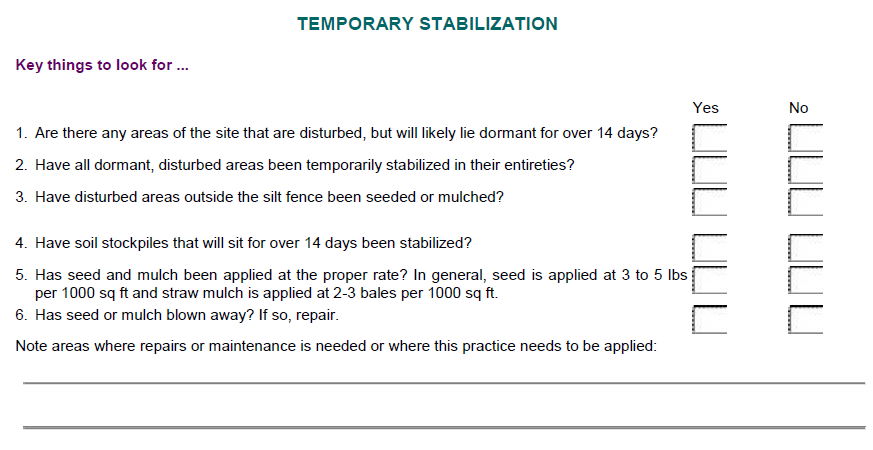
After seed emergence, check for vegetation density and note any bare or sparse areas. Monitor vegetation growth during the first two to five weeks, especially during dry conditions. If the seeding fails to grow, it may need to be re-established to provide adequate erosion prevention. Document any areas that need to be inter-seeded or reseeded, and areas where undesirable vegetation is emerging. Noxious weeds may need to be controlled by mowing or spraying.

MnDOT’s workmanship and rework schedule (2016; version under development at the time of manual update) identifies common deficiencies for various types of stabilization BMPs – including seeding – and corrective actions for these deficiencies. Once complete, the full, final version of this table will replace Table 2575-4 in [MnDOT *Standard Specifications for Construction*](http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf)(2016 edition).

Table 1‑5. Excerpt from Table 2575-4, Required Corrective Action

|  |  |  |
| --- | --- | --- |
| **Item** | **Corrective Action Required if:** | **Corrective action** |
| Seeding | Not uniformly placed  Not seeded with drill when required  Depth of seed placement incorrect  No cultipacking  Incorrect rate of seed application    (Hydroseeding) Insufficient soil coverage  Not mulched within 24 h  Incorrect seed mixture  Seed left in tank more than 24 hours  Seed left in tank more than 24 hours used | Reseed  Reseed  Reseed  Cultipack area  Apply additional seed as necessary to achieve correct rate  Reseed areas not covered properly with tracer  Reseed area  Reapply with correct mixture  Discard and start over  Reseed area |

The following is an example inspection checklist for temporary stabilization practices ([Source: Ohio EPA](https://www.dot.state.oh.us/Divisions/Planning/LocalPrograms/LTAP/Storm%20Water/530-790.pdf)).



Maintain downgradient sediment controls (e.g., silt fence, fiber rolls) until dense vegetation with uniform coverage is established. Irrigate seeded areas with portable, overhead sprinklers if dry conditions hinder germination or early growth. Cover bare or sparse areas with mulch until they can be reseeded or inter-seeded, which should be done at the earliest opportunity. Mow dense stands of undesirable species that shade out planted areas. Hoe or spot spray weeds as needed. During the first year of establishment, do not mow seedlings until after they are at least 6 inches tall while leaving a minimum height of 3 inches.

## Costs

The following table summarizes estimated BMP costs based on MnDOT data summarizing average bid prices for awarded projects in 2014. (*See subsequent sections for cost information on related erosion control products to provide protective cover such as mulch, erosion control blankets, etc.*).

Table 1‑6. Average Bid Prices (Based on Awarded Projects) for Spec Year 2014. Average price varies from year to year. Data for other years can be found on [MnDOT’s website](http://www.dot.state.mn.us/bidlet/average-bid-price.html). (Source: MnDOT)

| **Bid Item** | **Item Description** | **Units** | **Average Price** |
| --- | --- | --- | --- |
| 2575.501/00010 | Seeding | acre | $190.70 |
| 2575.502/21111 | Seed Mixture 21-111 | lb | $1.57 |
| 2575.502/21112 | Seed Mixture 21-112 | lb | $1.89 |
| 2575.502/21113 | Seed Mixture 21-113 | lb | $3.37 |
| 2575.502/22111 | Seed Mixture 22-111 | lb | $2.34 |

## Reference Materials

Except where more stringent requirements are presented in this guidance, BMPs shall comply with MnDOT and other state requirements. Primary design references include:

* MnDOT *Erosion Control Handbook II*

<http://www.dot.state.mn.us/environment/erosion/pdf/2006mndotecfieldhandbook.pdf>

* *Minnesota Urban Small Sites Best Management Practice Manual* (Vegetative Methods)

<http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Resources-Management/Water-Quality-Management-Key-Roles.aspx>

* 2013 Minnesota NPDES/SDS Construction Stormwater General Permit

<http://stormwater.pca.state.mn.us/index.php/Construction_stormwater_permit>

* MnDOT Seeding Manual, 2014 Edition. Office of Environmental Stewardship, Erosion Control Engineering Unit. http://www.dot.state.mn.us/environment/erosion/pdf/seedingmanual.pdf
* MnDOT *Standard Specifications for Construction* (2016 Edition)

<http://www.dot.state.mn.us/pre-letting/spec/>

The following is a list of additional resources that are not specific to Minnesota:

* Clark County Washington Stormwater Manual (BMP C120: Temporary and Permanent Seeding)

<https://www.clark.wa.gov/environmental-services/stormwater-code-and-manual>

* *Clean Water Services Erosion Prevention and Sediment Control Manual* (4.1.8 Seeding (Temporary/Permanent) <https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf>
* *North Carolina Erosion and Sediment Control Planning and Design Manual* (6.10 Temporary Seeding) <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>
* Northwest California Resource Conservation and Development District. 2016.5C Program Stormwater Management Handbook. <http://www.5counties.org/docs/roadedu/2012_5c_roads/rusle.pdf>
* Ohio EPA (Ohio Environmental Protection Agency). 2016. Construction Site Inspection Checklist for OHC000004. http://www.epa.ohio.gov/portals/35/storm/CGP\_Ins1.pdf.
* Tennessee Department of Environment and Conservation (TDEC) *Erosion and Sediment Control Handbook* (7.8 Temporary vegetation) <http://tnepsc.org/handbook.asp>
* *Virginia Erosion and Sediment Control Handbook* (3.31 Temporary Seeding) <http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx>
* Wisconsin Department of Natural Resources. Seeding for Construction Site Erosion Control (1059). [http://dnr.wi.gov/topic/stormwater/documents/SeedingForConstructionSiteErosion Control\_1059.pdf](http://dnr.wi.gov/topic/stormwater/documents/SeedingForConstructionSiteErosion%20Control_1059.pdf)

# Natural and Synthetic Mulches

## Definition

Natural and synthetic mulches include a wide range of practices used to cover seed and exposed soil. Mulch products are intended to reduce raindrop (splash) erosion, decrease sheet erosion, promote rain/snowmelt infiltration, increase soil moisture retention, regulate soil temperature, and in most cases, improve soil texture and increase organic matter. Mulch products include natural materials such as straw and other grasses, coconut fiber, and bark. Synthetic mulches combine a variety of chemical bonding agents with wood fibers, cellulose, or synthetic fibers (e.g., bonded fiber matrix). The mulch material may be disc-anchored into the soil, hydraulically bonded, or covered with netting and stapled. The choice of materials and anchoring of mulches should be based on slope steepness and length, soil conditions, season, type of vegetation, and size of the area.

## Purpose and Function

Soil stabilization with mulch is intended to counteract the erosive influences of rainfall, snowmelt, and wind on bare soil. Other benefits include soil moisture retention and improved soil texture. Mulches can be used for areas of the construction site that will be idle for 14 or more consecutive days to prevent erosion during lag times in grading operations, or they can be applied with seed or other vegetation to establish final, permanent cover for bare soil.

## Applicability

Stabilization with mulch applies to 1) areas of construction sites where soil disturbing activities have temporarily ceased, and measures are needed to prevent erosion and sediment runoff during rainfall or snowmelt; and 2) areas of the site that require permanent stabilization.

### 2.3.1 Site Applicability

Construction sites often have areas where soil disturbing activities such as clearing, grading, or cut/fill work has stopped for a period of time. Bare areas that are not actively being worked need some type of cover to prevent or minimize erosion in the event of rainfall or snowmelt. Applicable areas include topsoil stockpiles, rough graded areas, sediment basin dikes, temporary earthen structures and graded areas.

In addition, all areas of the site require permanent stabilization prior to project close out and termination of permit coverage. Mulch can be applied by hand, installed with mechanical spreaders/blowers, or sprayed hydraulically, depending on the product and site conditions. Mulch is often used instead of rolled erosion control products to support seed germination and early growth.

### 2.3.2 Permit Applicability

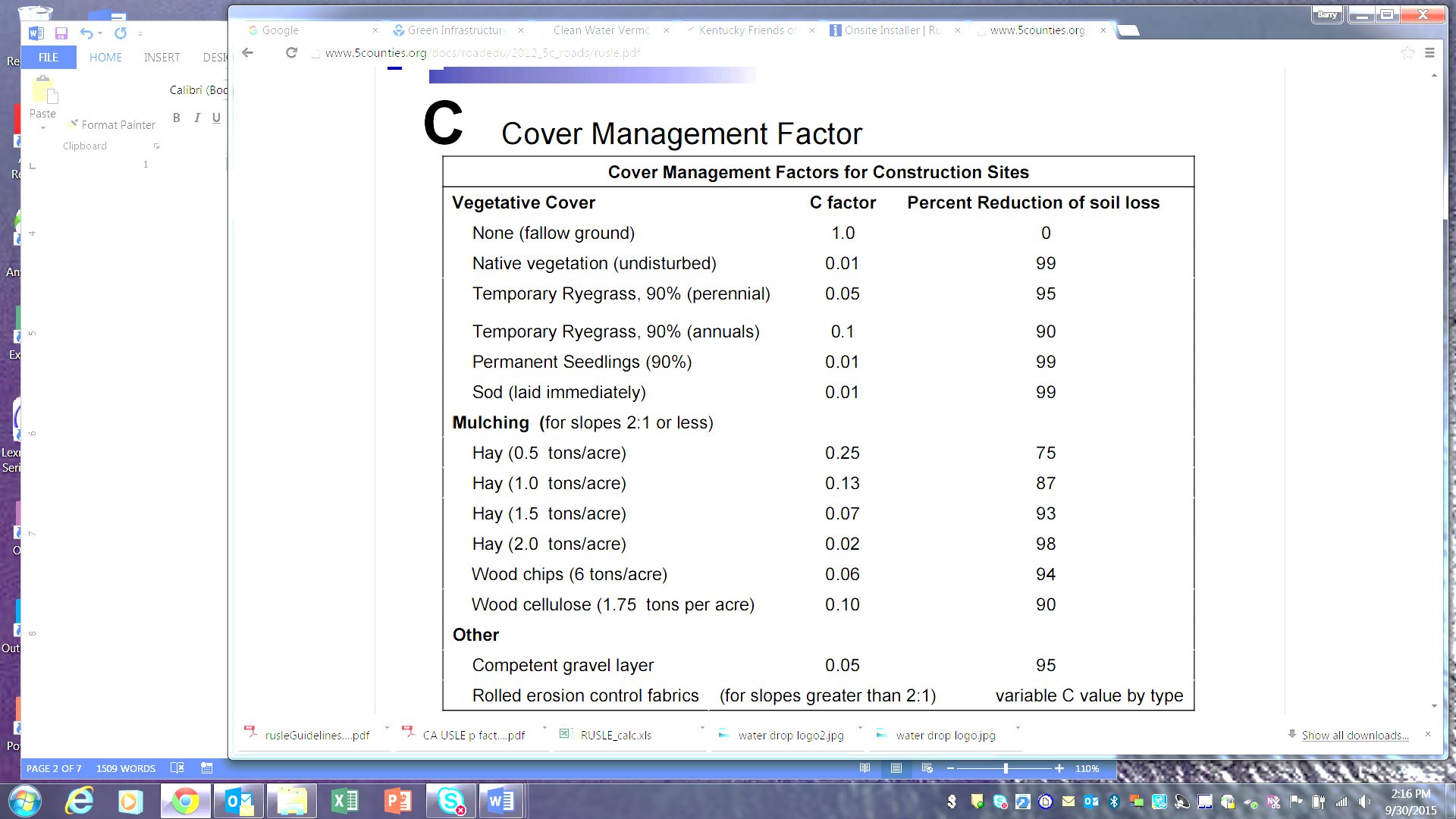
The MPCA Construction General Permit has several requirements regarding temporary stabilization with seed, mulch, or other methods.

* [Part IV.B.2](http://stormwater.pca.state.mn.us/index.php/IV._CONSTRUCTION_ACTIVITY_REQUIREMENTS#IV.B_EROSION_PREVENTION_PRACTICES) of the MPCA Construction General Permit states that the permittee(s) “must stabilize all exposed soil areas (including stockpiles). Stabilization must be initiated immediately to limit soil erosion whenever any construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days.” In addition, “(s)tabilization must be completed no later than 14 calendar days after the construction activity in that portion of the site has temporarily or permanently ceased.”
* Near public waters for which the Minnesota DNR has promulgated “work in water restrictions” during specified fish spawning time frames, all exposed soil areas that are within 200 feet of the water’s edge, and drain to these waters must complete the stabilization activities within 24 hours during the restriction period. Temporary stockpiles without significant silt, clay or organic components (e.g., clean aggregate stockpiles, demolition concrete stockpiles, sand stockpiles) and the constructed base components of roads, parking lots and similar surfaces are exempt from this requirement.
* Other permit stabilization requirements relate to permanent stabilization and stormwater controls. For sites discharging to special or impaired waters, [Appendix A Section C.1](http://stormwater.pca.state.mn.us/index.php/APPENDIX_A) of the MPCA Construction General Permit requires that (s)tabilization of all exposed soil areas must be initiated immediately to limit soil erosion but in no case completed later than seven (7) days after the construction activity in that portion of the site has temporarily or permanently ceased.”
* [Appendix B Section 26](http://stormwater.pca.state.mn.us/index.php/APPENDIX_B_-_DEFINITIONS) of the MPCA Construction General Permit defines stabilization as meaning that “the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring. Grass, agricultural crop or other seeding alone is not stabilization. Mulch materials must achieve approximately 90 percent ground coverage (typically 2 ton/acre).”

## Effectiveness

Temporary and permanent stabilization with mulch or other products is highly effective in reducing soil loss from construction sites (see Table 2‑1). Vegetative cover can reduce erosion by up to 99 percent, with the application of mulch at the MPCA recommended rate of two tons per acre achieving similar results. Because seeding is only effective after plants have emerged, the application of straw mulch or other cover is required to stabilize exposed surfaces and help establish vegetation growth. Table 2‑2 summarizes expected performance for an array of typical water quantity and quality target constituents for natural and synthetic mulches. Refer to Reference Materials for additional links to reported soil loss reduction values among various mulch types.

Table 2‑1. Bare soil cover types and percent reduction of soil loss



Source: Northwest California Resource Conservation and Development District 2016

Table 2‑2. Expected performance for natural and synthetic mulches

|  |  |
| --- | --- |
| **Water Quantity** | |
| Flow attenuation | ○ |
| Runoff volume reduction | ○ |
| **Water Quality** | |
| **Pollution prevention** | |
| Soil erosion | ● |
| Sediment control | ○ |
| Nutrient loading | ● |
| **Pollutant removal** | |
| Total suspended solids | ● |
| Total phosphorus | ● |
| Heavy metals | ◖ |
| Floatables | ○ |
| Oil and grease | ○ |

● Primary design benefit

◖ Secondary design benefit

○ Little or no design benefit

## Planning Considerations

A key stormwater planning objective should be to keep the bare soil footprint at the site as small as possible by stabilizing inactive areas with mulch or other means until construction resumes in those portions of the site, or until temporary or permanent cover has been established. Planning and staging projects in a manner that minimizes the extent and duration of soil disturbance helps to reduce both erosion and sediment loss. In practice, this often means scheduling operations to complete clearing, grading, and cut/fill operations in a phased manner, so that manageably sized cleared and graded areas can be temporarily – or permanently – stabilized as the project proceeds. Planning approach examples include:

* Subdivision development – complete clearing, grading, and primary road layout, then temporarily seed and mulch home site and secondary road locations until construction begins in those areas.
* Commercial projects – grade building footprint(s) and proposed landscaped areas, then seed and mulch them and focus construction and material storage on areas immediately adjacent to the building pad(s). Parking lots can be graveled and used for material storage, staging, and parking.
* Institutional and manufacturing facilities – same as commercial projects. Keep activities close to the vertical construction site, minimize disturbed areas, and temporarily seed and mulch idle areas.

Site personnel with minimal training can install most mulch materials (e.g., straw, rolled products). However, outside contractors are often needed to apply synthetic, hydraulically applied products (e.g., bonded fiber matrix). Keeping a supply of straw or other temporary cover (e.g., rolled erosion control products) on hand can help to ensure that temporary seeding is implemented both regularly and quickly. High priority areas for immediate stabilization include areas within 50-100 feet of a lake, river, stream, or wetland; slopes steeper than 4H:1V; and ditches and channels within 200 feet of a waterbody or property line.

Additional important planning considerations include:

* Mulch temporary or permanent seed installations immediately.
* Areas where vegetation cannot be established because of the season should be mulched to temporarily protect the soil surface.
* Mulching is especially important when conditions for germination are not optimum, such as midsummer and early winter, and on difficult areas, such as cut slopes and slopes with southern exposures.
* After mulching, seed the area as soon as conditions are favorable for germination and seedling growth.
* Do not use materials that may contain competing weed and grass seeds.
* Mulch may be spread by hand or with a mulch blower. Straw may be lost to wind and must be chemically or mechanically anchored to the soil immediately after it is spread.
* Additional methods, including erosion control blankets and turf-reinforcement mats, may be needed in critical areas such as waterways and channels and slopes steeper than 3:1.
* Tackifiers, or chemical soil stabilizers and soil binders, are useful for tacking organic mulches (see next subsection).
* Various types of netting materials are also available to anchor organic mulches.

The current list of MnDOT certified/approved vendors for mulch are available on the MnDOT website:

<http://www.dot.state.mn.us/environment/erosion/certifiedvendors.html>

## Design

Key design parameters for mulch application are 1) the length of time stabilization is needed (i.e., temporarily or permanently); 2) whether the mulch will be used as a stand-alone cover or with seed; 3) site conditions, such as size, slope steepness, slope length, and accessibility; 4) available labor and equipment; and 5) cost. Mulch provides temporary and/or permanent stabilization of soil during and at the completion of construction, and aids in seed germination for vegetation establishment. Before mulching, install any needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, grass-lined channels and sediment basins. Table 2‑3 lists various mulch types, including their recommended application method.

Table 2‑3. Types of mulch products typically used on construction sites

|  |  |  |
| --- | --- | --- |
| **Mulch type** | **Description** | **Application Method** |
| Straw, hay, or other grasses | Wheat, oat, or pine straw; rolled or baled pasture grasses also used in some cases | Hand scattering for small areas; chopper/blower used for larger areas, sometimes with co-applied tackifying agent to promote adhesion |
| Wood chips, bark, sawdust | Waste product from sawmills and other timber harvest and processing operations | Hand scattering or mechanized spreader |
| Rock | Can include all classes of aggregate, riprap, and large stone; used for permanent erosion protection | Placement by hand or equipment (e.g., track-hoe, skidder, front-end loader) |
| Hydraulically applied mulches | Bonded fiber matrix products, including those manufactured with natural and/or synthetic fibers, cellulose, or other materials | Spray application via high-pressure pumping from the mixing tank, through a hose and nozzle apparatus |

Source: Wisconsin Department of Natural Resources, Mulching for Construction Sites

Table 2‑4 lists various mulch types, application rates, and pros/cons. Note that rolled erosion prevention/control products – temporary erosion control blankets or permanent turf reinforcement mats – are often used instead of mulch.

Table 2‑4. Mulch types, application rates, benefits, and limitations

|  |  |  |  |
| --- | --- | --- | --- |
| **Mulch Type** | **Application Rate** | **Benefits** | **Limitations** |
| Straw, hay, or other grasses | 11/2 to 21/2 tons per acre | Readily available and inexpensive; very effective in controlling erosion; can be applied on large sites via blower | Can carry unwanted seeds; might need tackifier or anchoring,  especially on steep slopes |
| Wood chips, bark, sawdust | 5 to 8 tons per acre | Very low cost in some locations; chips can be effective on slopes up to 30% | High nitrogen demand when decomposing; can float away or blow away during rain storms |
| Rock | 200 to 500 tons per acre | Could be inexpensive and readily available in some locales; might be suitable for smaller sites | Inhibits plant growth; adds no nutrients to the soil; can be costly to apply on slopes and large sites; adds hardened look to slopes |
| Hydraulically applied mulches | 11/2 to 21/2 tons per acre | Easily and rapidly applied with sprayer equipment; can include seed, fertilizer, flexible/fibrous mulches, and soil binders | Could be too expensive for small or very remote sites; after application, must dry for at least 24 hours before rainfall |

Source: Kentucky Division of Water

Where mulches are used in conjunction with vegetation establishment, they should be selected to last as long as it takes to establish effective vegetative erosion prevention. On slopes greater than 2.5H:1V, or where the selected product mulch is susceptible to movement by wind or water (e.g., straw), the mulch material should be hydraulically applied or appropriately anchored. Bonded fiber matrix mulches and tackifying agents are used effectively to bind mulch materials and prevent displacement by wind or rain. Straw mulch can also be covered by degradable netting or secured by crimping into the soil. Other mulch application considerations are listed below.

### C:\Users\john.kosco\Documents\Photos\Construction\Barry\mulchstraw.JPG2.6.1 Straw and other grasses

Figure ‑. Construction site with straw mulch for temporary stabilization

*Source: Tetra Tech, Barry Tonning*

Wheat, oat, barley, and rice straw make excellent mulch. Because of its length and bulk, straw is highly effective in reducing the impact of raindrops and in moderating the microclimate of the soil surface. Straw mulch can be applied by hand on small sites and blown on by machine on large sites. Straw blowers have a range of about 50 feet. Some commercial models advertise a range up to 85 feet and a capacity of 15 tons per hour. Straw mulch should not be applied more than 2 inches deep on seeded sites, unless it is incorporated into the soil by tracking, disking (crimping), or other ground-securing techniques. If the straw is applied at rates higher than 3 tons per acre, the mulch could be too dense for the sunlight and seedlings to penetrate. Look for clean straw to prevent the spread of noxious weeds. Avoid moldy, compacted straw because it tends to clump and is not distributed evenly.

The straw must be evenly distributed by hand or machine to the desired depth (about 2 inches maximum), and should cover the exposed area to a uniform depth. One bale (approximately 80 lbs) of straw covers about 1,000 square feet adequately. The soil surface should be barely visible through the straw mulch. On steep or high-wind sites, straw must be anchored to keep it from blowing away. Straw mulch is commonly anchored by crimping, tracking, disking, punching into the soil, covering with a net, spraying with asphaltic or organic tackifier, or tacking with cellulose or other product. These various straw mulch anchoring techniques are described as follows:

* **Hand Punching** - On small sites where straw has been distributed by hand, it can be anchored by hand punching it into the soil every 1–2 feet with a dull, round-nosed shovel. A sharp shovel will merely cut the straw and not anchor it.
* **Crimping** - A mulch anchoring tool is a tractor-drawn implement designed to punch and anchor mulch into the top 2–8 inches of soil. This practice affords maximum erosion prevention but is limited to flatter slopes where equipment can operate safely.
* **Disking** - A set of harrow discs can be straightened (not angled) and used to press the straw into the soil. Angled disk alignments are designed to turn soil and will cause too much disturbance.
* **Tracking** – Tracking, which is the process of pushing straw into the soil using a bulldozer or other equipment with cleated tracks, is used primarily on slopes 3:1 or flatter where this type of equipment can safely operate. Tracking equipment must operate up and down the slope so the cleat tracks are perpendicular to flow.
* **Netting** - Netting material made of biodegradable paper, plastic or cotton netting can be used to cover straw mulch. Netting should be specified judiciously since birds, snakes and other wildlife can get trapped in the net.
* **Tackifiers** - Polymer tackifiers are generally applied at rates of 40–60 pounds per acre, however manufacturers’ recommendations vary. Organic tackifiers are generally applied at rates of 80–120 pounds per acre, but again, manufacturers’ recommendations vary. Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and areas where the mulch could be moved by wind or water. All other areas must have a uniform application of the tackifier.

### 2.6.2 Wood chips or bark

Applied at a rate of 5–8 tons per acre, this mulch material should also be evenly distributed across the surface to a depth of about 2 inches. If soil building and revegetation are desired, increase the application rate of nitrogen fertilizer by 20 pounds of nitrogen per acre. This compensates for the temporary loss of available nitrogen to soil microbes as they break down the carbon-rich mulch.

### 2.6.3 Rock

Rock may be useful for stabilizing long slopes that will not support thickly seeded grass. Install non-woven geotextile on graded slopes and place rock of mixed sizes on the geotextile, starting at the bottom and working uphill. Generally, rock is not suitable for residential or other areas where aesthetics are a design consideration.

### 2.6.4 Hydraulic mulches

Hydraulic mulch (also known as hydromulch) can be used to rapidly stabilize critical areas that are difficult to reach or are located on slopes greater than 3:1. The specific composition of the mulch and application rates vary. In general, a hydraulic mulch is a processed material that can be applied in a continuous stream when mixed with water, and can vary in type, composition, additive materials, and durability (i.e., from light-duty to heavy-duty). When applied, hydraulic mulches form a thick crust or mat-like barrier that controls water and wind induced erosion.

Figure ‑. Close-up photo of hydromulch application

*Source: Tetra Tech, John Kosco*

Hydraulic mulches can be made of recycled newsprint, magazines, wood or other wood/paper waste sources. Many proprietary products feature a mix of natural and synthetic fibers and cellulose. This type of mulch is typically mixed in a hydraulic application machine (hydroseeder) and applied via sprayer as a liquid slurry at a minimum rate of 1.5 tons per acre. The slurry usually contains a dye to aid in visual metering during application, although the dye must be biodegradable and not inhibit plant growth. Hydraulic mulches can also contain the recommended rates of seed and fertilizer for the site, and be specified with or without a tackifier (*note: tackifiers are discussed further in “Tackifiers and Soil Stabilizers”*). Hydraulic mulches from wood and paper fiber are combination mulches generally composed of 70 percent wood fiber and 30 percent paper fiber, and manufactured from lumber mill waste, virgin wood chips, recycled newsprint, office paper and/or other waste paper.

One or two application rates are generally specified for hydraulic mulch. The first is the blanket equivalent rate required for erosion prevention (usually between 3,000 and 4,000 pounds per acre). The other, typically half the erosion blanket control rate, is useful for enhancing seed germination and soil stabilization where slopes are 6:1 or flatter. The following table summarizes MnDOT approved products for hydraulic mulch.

Table 2‑5. MnDOT approved/qualified hydraulic mulch products

|  |  |  |
| --- | --- | --- |
| **Brand/Model Name** | **Manufacturer** | **Date Approved** |
| ***Hydraulic Compost Matrix*** | | |
| TerraVita HGM | Organic Earth Industries | 4-2014 |
| Biotic Earth Black | ErosionControlBlanket.com | 11-2014 |
| ***Hydraulic Mulch Matrix*** | | |
| Verdyol Virgin Plus | ErosionControlBlanket.com | 10-2015 |
| Excel Fibermulch II Bindex Wood WT | American Excelsior Co | 5-2011 |
| Second Nature Wood Fiber Plus Enviro-Gold Plus Second Nature  Wood Fiber Blend Plus Enviro Mix Plus (40-60%) | Central Fiber Corp. | 3-2014 |
| HydroStraw Guar Plus HydroStraw Straw Lock | HydroStraw | 9-2014 |
| Mat-Blend Plus, Mat Fiber Plus | Mat Inc. | 4-2014 |
| Conwed Fibers 2000  Terra Wood with Tack  Eco-Fibre Plus Tackifier  Conwed Fibers EnviroBlend with Tack  Terra-Blend with Tack | Profile Products | 6-2014  6-2014  6-2014  11-2014  11-2014 |
| Hydra GT | Tensar/No.Am.Green | 9-2014 |
| ***Stabilized Fiber Matrix*** | | |
| Spray Guard | Mat Inc. | 4-2014 |
| Terra-Matrix SMM | Profile Products | 9-2014 |
| Hydra CM | Tensar/No. Am Green | 9-2014 |
| ***Bonded Fiber Matrix*** | | |
| Verdyol Virgin BFM | ErosionControlBlanket.com | 10-2015 |
| Bindex BFM | American Excelsior Co. | 5-2011 |
| Spray Matt, Enviro Matt | Central Fiber Corp. | 3-2014 |
| Soil Guard | Mat Inc. | 4-2014 |
| ProMatrix  Hydro Blanket BFM | Profile Products | 8-2012  6-2014 |
| ***Fiber Reinforced Matrix*** | | |
| Spray Matrix  Enviro-Matrix | Central Fiber Corp. | 3-2014 |
| Flex Guard | Mat Inc. | 4-2014 |
| Hydra CX | Tensar/No. Am Green | 11-2014 |
| Earth Guard Fiber Matrix | Terra Nova | 3-2015 |
| Flexterra HP | Profile Products | 4-2014 |

Important considerations for hydraulic mulch application include the following:

* Spraying of hydraulic mulch should not be performed during windy conditions, which would prevent the proper placement.
* The contractor should protect all traffic, signs, structures and other objects from being marked or disfigured by the mulch/tackifier material.
* The tackifiers specified should be applied at the manufacturer’s recommended rate.
* The tackifier can be premixed by the manufacturer, or can be added in the field.
* The tackifier should comprise 2-5 percent by weight.
* Blended mulches are not typically intended for use on areas with high erosion potential.
* Hydraulic mulches are an excellent germination medium, and should be considered on flatter slopes and hard-to-reach areas.
* The use of wood fiber mulch in combination with straw has been found to be very effective.
* Seeding and fertilizing should be done prior to mulching.
* Disk-anchoring is not required with this practice, which makes this an ideal alternative for hard-to-reach areas where disk-anchoring is not possible.

## Standards and Specifications

MnDOT Specification 2575.3 part C (page 504) provides guidance for mulch application, including application methods, MnDOT mulch types, and winter considerations. Part D (page 504) covers disk anchoring of mulch (applicable to Types 1, 3, and 8). Part K.4 (page 508) covers maintenance of mulch. Specification 2575.4.C (page 510) prescribes requirements for measurement of mulch, and Specification 2575.4.E (page 510) covers measurement of disk anchoring. Mulch should meet Specification 3882 (“Mulch Material”; pages 675-676). The 2016 edition of the MnDOT *Standard Specifications for Construction* can be found here:

<http://www.dot.state.mn.us/pre-letting/spec/> (See <http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf>, page 504.)

## Inspection and Maintenance

Inspect mulched areas weekly and after rainstorms to check for rill erosion, dislocation, or failure. Repair or replace any bare areas promptly. If properly applied and anchored, little additional maintenance is required for mulch during the first few months. After high winds or significant rainstorms, mulched areas should be checked for adequate cover and re-mulched if necessary. For permanent stabilization, mulch needs to last until vegetation is well established to provide permanent erosion resistant cover. Straw mulch can last from 6 months to 3 years, depending on local conditions. For permanent stabilization, maintain downgradient sediment controls (e.g., silt fence, fiber rolls) until dense vegetation with fairly uniform coverage is established. Irrigate seeded areas if dry conditions hinder germination or early growth. Cover bare or sparse areas with mulch until they can be reseeded or inter-seeded, which should be done at the earliest opportunity.

MnDOT’s workmanship and rework schedule in Table 2‑6 (2016; version under development at the time of manual update) identifies common deficiencies for various types of stabilization BMPs – including mulch – and corrective actions for these deficiencies. Once complete, the full, final version of this table will replace Table 2575-4 in [MnDOT *Standard Specifications for Construction*](http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf)(2016 edition).

Table 2‑6. Excerpt from Table 2575-4, Required Corrective Action

|  |  |  |
| --- | --- | --- |
| **Item** | **Corrective Action Required if:** | **Corrective action** |
| Mulch material, hydraulic erosion control products | Incorrect rate of application  Not uniformly placed  Rutting on slopes from equipment  Improper anchoring  Broken disks, wrong angle | Remulch to provide proper coverage  Adjust placement of mulch to provide uniform placement  Fix ruts, remulch and reseed  Re-anchor the mulch  Use equipment designed for anchoring |

## Costs

The following table summarizes estimated BMP costs based on MnDOT data summarizing average bid prices for awarded projects in 2014.

Table 2‑7. Average Bid Prices (Based on Awarded Projects) for Spec Year 2014. Average price varies from year to year. Data for other years can be found on [MnDOT’s website](http://www.dot.state.mn.us/bidlet/average-bid-price.html). (Source: MnDOT)

| **Bid Item** | **Item Description** | **Units** | **Average Price** |
| --- | --- | --- | --- |
| 2575.511/00010 | Mulch Material Type 1 | ton | $178.58 |
| 2575.511/00030 | Mulch Material Type 3 | ton | $411.45 |
| 2575.513/00050 | Mulch Material Type 5 | CY | $13.63 |
| 2575.513/00060 | Mulch Material Type 6 | CY | $65.27 |
| 2575.513/00090 | Mulch Material Type 9 | CY | $64.92 |
| 2575.519/00010 | Disk Anchoring | acre | $94.65 |
| 2575.562/00020 | Hydraulic Matrix Type Mulch | lb | $0.65 |
| 2575.562/00030 | Hydraulic Matrix Type Bonded Fiber | lb | $11.00 |
| 2575.562/00040 | Hydraulic Matrix Type Fiber Reinforced | lb | $1.46 |

## Reference Materials

Except where more stringent requirements are presented in this guidance, BMPs shall comply with MnDOT and other state requirements. Primary design references include:

* MnDOT *Erosion Control Handbook II*

<http://www.dot.state.mn.us/environment/erosion/pdf/2006mndotecfieldhandbook.pdf>

* *Minnesota Urban Small Sites Best Management Practice Manual* (Mulches, Blankets and Mats)

<http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Resources-Management/Water-Quality-Management-Key-Roles.aspx>

* 2013 Minnesota NPDES/SDS Construction Stormwater General Permit <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/construction-stormwater/index.html>
* MnDOT *Standard Specifications for Construction* (2016 Edition)

<http://www.dot.state.mn.us/pre-letting/spec/>

* MnDOT Approved/Qualified Products for Hydraulic Erosion Control

<http://www.dot.state.mn.us/products/erosioncontrolandlandscaping/hydraulicerosioncontrol.html>

The following is a list of additional resources that are not specific to Minnesota:

* Clark County Washington Stormwater Manual (BMP C121: Mulching)

<https://www.clark.wa.gov/environmental-services/stormwater-code-and-manual>

* *Clean Water Services Erosion Prevention and Sediment Control Manual* (4.1.3 Ground Cover, 4.1.4 Hydraulic Applications, 4.1.5 Matting) <https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf>
* Kentucky Division of Water *Kentucky Construction Site BMP Planning and Technical Specifications Manual* (4.4 Soil Stabilization).

<http://transportation.ky.gov/Environmental-Analysis/Environmental%20Resources/2-Soil%20Stabilization.pdf>

* *North Carolina Erosion and Sediment Control Planning and Design Manual* (6.14 Mulching, 6.17 Rolled Erosion Control Products) <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>
* Northwest California Resource Conservation and Development District. 2016.5C Program Stormwater Management Handbook. <http://www.5counties.org/docs/roadedu/2012_5c_roads/rusle.pdf>
* Tennessee Department of Environment and Conservation (TDEC) *Erosion and Sediment Control Handbook* (7.6 Stabilization with straw mulch, 7.7 Stabilization with other mulch materials, 7.12 Hydro Applications) <http://tnepsc.org/handbook.asp>
* US Forest Service. Erosion and Sediment Control BMPs: Installed Costs and Effectiveness. <https://www.fws.gov/fire/ifcc/esr/library/E&SC%20BMP%20costeffectiveness.pdf>
* *Virginia Erosion and Sediment Control Handbook* (3.35 Mulching, 3.36 Soil Stabilization Blankets and Matting) <http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx>
* Wisconsin Department of Natural Resources, Mulching for Construction Sites. <http://dnr.wi.gov/topic/stormwater/documents/MulchingForConstructionSites_1058.pdf>

# Tackifiers and Soil Stabilizers

## Definition

Tackifiers and soil stabilizers are hydraulically applied chemicals derived from natural and synthetic sources used to promote adhesion among soil particles or mulch materials. In general, soil stabilizers (also known as soil binders) are used to increase soil adhesion, which improves soil stabilization by reducing water and wind driven erosion. Tackifiers are used as “glue” to bind and immobilize straw, cellulose products, pine needles, or other mulch that has been applied to a seeded area. Tackifiers protect seedbeds by holding the product to the soil surface and preventing movement. Relevant products include polyacrylamide, guar, chloride compounds, psyllium, resins, enzymes, surfactants, and various polymers, starches, and other compounds. Petroleum based tackifiers, once widely applied to straw mulch, have largely been replaced with other products that are easier to handle, break down naturally, and present fewer overall health and environmental risks.

## Purpose and Function

Chemical based soil stabilization is intended to counteract the erosive influences of rainfall, snowmelt, and wind on bare soil. The use of tackifiers to prevent the movement of mulch material by wind and rain helps to keep straw and/or other mulches in place, preventing soil erosion. Erosion prevention practices are the easiest, cheapest, and most effective approach for addressing muddy runoff and dust from construction sites. Stabilizers and tackifiers are temporary measures, designed to prevent short-term (e.g., two to four weeks) erosion between construction periods, and during seed germination and early growth for permanent stabilization. While they are effective for a wide range of soil, slope, temperature, and rainfall conditions, they are not intended for use in concentrated flow locations, such as ditches and channels.

## Applicability

Site stabilization with soil binders and tackifier bonded mulch (e.g., straw, other fibers) applies to 1) areas of construction sites where soil disturbing activities have temporarily ceased, and measures are needed to prevent erosion and sediment runoff during rainfall or snowmelt; and 2) areas of the site that require permanent stabilization.

### 3.3.1 Site Applicability

Construction sites often have areas where soil disturbing activities such as clearing, grading, or cut/fill work has stopped for a period of time. Bare areas that are not actively being worked need some type of cover or stabilization practice to prevent or minimize erosion in the event of rainfall or snowmelt. Tackifiers and soil stabilizers are applied hydraulically to reduce erosion by binding soil particles or mulch materials, often in conjunction with temporary or permanent seeding. Applicable areas include topsoil stockpiles, rough graded areas, sediment basin dikes, temporary earthen structures, and graded areas. Tackifiers and soil stabilizers can be used in conjunction with seed and mulch materials to achieve temporary and/or permanent stabilization.

### 3.3.2 Permit Applicability

The MPCA Construction General Permit has several requirements regarding temporary stabilization. [Part IV.B.2](http://stormwater.pca.state.mn.us/index.php/IV._CONSTRUCTION_ACTIVITY_REQUIREMENTS#IV.B_EROSION_PREVENTION_PRACTICES) of the MPCA Construction General Permit states that the permittee(s) “must stabilize all exposed soil areas (including stockpiles). Stabilization must be initiated immediately to limit soil erosion whenever any construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days.” In addition, “(s)tabilization must be completed no later than 14 calendar days after the construction activity in that portion of the site has temporarily or permanently ceased.”

Near public waters for which the Minnesota DNR has promulgated “work in water restrictions” during specified fish spawning time frames, all exposed soil areas that are within 200 feet of the water’s edge, and drain to these waters must complete the stabilization activities within 24 hours during the restriction period. Temporary stockpiles without significant silt, clay or organic components (e.g., clean aggregate stockpiles, demolition concrete stockpiles, sand stockpiles) and the constructed base components of roads, parking lots and similar surfaces are exempt from this requirement.

Other permit stabilization requirements relate to permanent stabilization and stormwater controls. For sites discharging to special or impaired waters, [Appendix A Section C.1](http://stormwater.pca.state.mn.us/index.php/APPENDIX_A) of the MPCA Construction General Permit requires that (s)tabilization of all exposed soil areas must be initiated immediately to limit soil erosion but in no case completed later than seven (7) days after the construction activity in that portion of the site has temporarily or permanently ceased.”

As the permit notes, stabilization requires more than seed alone. [Appendix B Section 26](http://stormwater.pca.state.mn.us/index.php/APPENDIX_B_-_DEFINITIONS) of the MPCA Construction General Permit defines stabilization as meaning that “the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring. Grass, agricultural crop or other seeding alone is not stabilization. Mulch materials must achieve approximately 90 percent ground coverage (typically 2 ton/acre).”

## Effectiveness

Hydraulically applied products have undergone rapid development and improvement during the past ten years and now provide seed establishment and soil protection performance equal or superior to conventional seeding and mulching practices. Temporary and permanent stabilization with mulch-adhered tackifiers and soil stabilizers is effective in reducing soil loss from construction sites by increasing mulch longevity and preventing mulch displacement via wind and heavy rain. Tackifiers used as adhesives in hydraulically applied mulches (e.g., bonded fiber matrix, other hydromulches) have been used for decades, and provide results similar to rolled erosion control products in non-channel applications when selected, prepared, and applied in accordance with manufacturer’s directions. Chemical soil stabilizers bind the soil, helping it to further resist raindrop, sheet, and rill erosion. Soil stabilizers, when used as adhesives, are effective for dust control, short-term erosion prevention, and roadway stabilization. Some stabilizers, such as polyacrylamide, can be used as coagulants in sediment ponds to promote flocculation and settling. Table 3‑1 summarizes expected performance for an array of typical water quantity and quality target constituents for tackifiers and soil stabilizers.

Table 3‑1. Expected performance for tackifiers and soil stabilizers

|  |  |
| --- | --- |
| **Water Quantity** | |
| Flow attenuation | ○ |
| Runoff volume reduction | ○ |
| **Water Quality** | |
| **Pollution prevention** | |
| Soil erosion | ● |
| Sediment control | ○ |
| Nutrient loading | ● |
| **Pollutant removal** | |
| Total suspended solids | ● |
| Total phosphorus | ● |
| Heavy metals | ◖ |
| Floatables | ○ |
| Oil and grease | ○ |

● Primary design benefit

◖ Secondary design benefit

○ Little or no design benefit

## Planning Considerations

A key benefit of hydraulically applied products is the ability to treat large sites with steep (3H:1V to 1H:1V), long slopes or other areas where installation of ECBs or turf reinforcement mats is difficult. A nearby source of water (or water tank) to mix the slurry is necessary for large sites. Typical hydraulic soil cover applications include a slurry-like mix of seed, fertilizer, and mulch. Also available for inclusion are other amendments such as tackifier and a variety of fibrous materials that dry to form a flexible net or crust that provides excellent protection for bare soil before seed germination.

Application equipment ranges from small, hand-pulled polyethylene units with electric sprayers and tanks that hold up to 15 pounds of seed, fertilizer, and mulch, to large towed or truck-mounted machines with tanks of 100 to 2,000 gallons. Mixing ratios will vary significantly by application, but a standard turf application for one acre will typically include 100 to 150 pounds of seed (or more, depending on seed variety and site conditions), 300 to 400 pounds of fertilizer, 140 pounds of binder, and 1,500 to 2,000 pounds of fiber mulch mixed with 4,000 or more gallons of water.

As soil binder types (see Table 3‑2 for MnDOT approved products) and uses have expanded in recent years, refer to the following when selecting a binder product:

* Soil types, slopes, and circumstances: What types of soils are present, how steep are they, and what is the slope length? Is the slope graded smooth or is it rough? Will the binder require resistance to leaching or abrasion? Is there existing vegetation to preserve? How long will the binder need to remain effective?
* Application: Is there sufficient water nearby to mix the product? Are the slopes accessible to the tank/sprayer equipment? Can the equipment effectively treat the area(s) under review? How frequently must applications be made? Are the manufacturer’s applications rates being followed?
* Product requirements: What are the required application conditions for the specific product under consideration – including soils, slopes, wetness/dryness, surface conditions (i.e., smooth/rough, compacted/loose, etc.)?
* Costs, equipment, and labor required for accessing, transporting, preparing, applying, and maintaining the product.

Table 3‑2. MnDOT approved/qualified hydraulic erosion prevention/control products (tackifiers)

|  |  |  |
| --- | --- | --- |
| **Brand/Model Name** | **Manufacturer** | **Date Approved** |
| ***Hydraulic Natural Tackifier*** | | |
| StarTak 600 | Chemstar | 5-2013 |
| FiberRX | HydroStraw | 3-2014 |
| HydraTack | Innovative Turf Solutions | 3-2013 |
| ConTack | Profile Products | 9-2014 |
| HF5000 Tack, Super Tack, SpecTac | Rantec Corporation | 4-2013, 12-2013, 9-2013 |
| ***Hydraulic Polyacrylamide Tackifier*** | | |
| FlocLoc | Profile | 12-2015 |

Below is summary information on some of the most widely used soil binders.

*Binders from plant materials, lasting less than six months:*

* Guar is a non-toxic, biodegradable, natural colloidal product treated with dispersant agents for easy field mixing. It should be mixed with water at the rate of 11 to 15 pounds per 1,000 gallons. Recommended minimum application rates range from 40 pounds per acre for flat areas to 70 pounds per acre for 1H:1V slopes.
* Psyllium is composed of the finely ground coating of plantago seeds, and is applied as a dry powder or in a wet slurry to the surface of the soil. Although it dries to form a firm but re-wettable membrane that binds soil particles together, it permits germination and growth of seed. Psyllium should be sufficiently mixed and diluted to provide uniform flow for application rates of 80 to 200 pounds per acre. Note that this product requires a 12 to 18 hour drying time prior to the next precipitation event.
* Starch is non-ionic, cold water soluble granular cornstarch mixed with water and applied at the rate of 150 pounds per acre. Approximate drying time is 9 to 12 hours.

*Binders from plant materials, lasting six to twelve months:*

* Pitch and rosin emulsions are manufactured from natural resins and generally have a minimum solids content of 48 percent. The rosin should be at least 26 percent of the total solids content, non-corrosive, dilutable, and cure to form a water insoluble binding and cementing agent. For soil erosion prevention applications, the emulsion is diluted and should be applied at 5 parts water to 1 part emulsion for clayey soils, or 10 parts water to 1 part emulsion for sandy soils.

*Polymeric emulsion blends:*

* Acrylic copolymers and polymers consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55 percent solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming (or include an anti-foaming agent). For all such compounds, product expiration dates should be checked. These products should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should stabilize the soil without totally inhibiting water infiltration, and should not re-emulsify when cured. Drying time is 12 to 24 hours. Liquid copolymers should be diluted at a rate of 10 parts water to 1 part polymer and applied to soil at a rate of 1,175 gallons per acre.
* Liquid polymers of methacrylates and acrylates consist of a tackifier/sealer that is an aqueous blend of 40 percent solids by volume, free from styrene, acetate, vinyl, ethoxylated surfactants, or silicates. The product is diluted with water as per manufacturer’s recommendations and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours.
* Copolymers of sodium acrylates and are non-toxic, dry powders that are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient (i.e., 3 to 5 pounds per acre for flat areas, 5 to 10 pounds per acre for slopes 5H:1V to 10H:1V, and 10 to 20 pounds per acre for slopes 2H:1V to 1H:1V.
* Polyacrylamide (PAM) and copolymer of acrylamide are packaged as a dry flowable solid and diluted at a rate of 11 pounds per 1,000 gallons of water. It is typically applied at a rate of 5 pounds per acre, or per the manufacturer’s recommendations. Ensure that the product selected in anionic -- cationic products are toxic to aquatic environments. Stormwater flows from slopes with PAM above waterbodies should pass through a sediment trap or basin. Do not use PAM as a standalone practice, as its effectiveness improves significantly when combined with mulch.
* Hydrocolloid polymers are various combinations of dry flowable polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 pounds per acre. Drying times range up to four hours.

*Cementitious binder products:*

* Gypsum readily mixes with water and mulch to form a thin protective crust on the soil surface. Gypsum is ground, calcined and processed to be mixed in a hydraulic seeder and applied at rates 4,000 to 12,000 pounds per acre. Drying time is 4 to 8 hours.

*Products used primarily for unpaved roadway stabilization:*

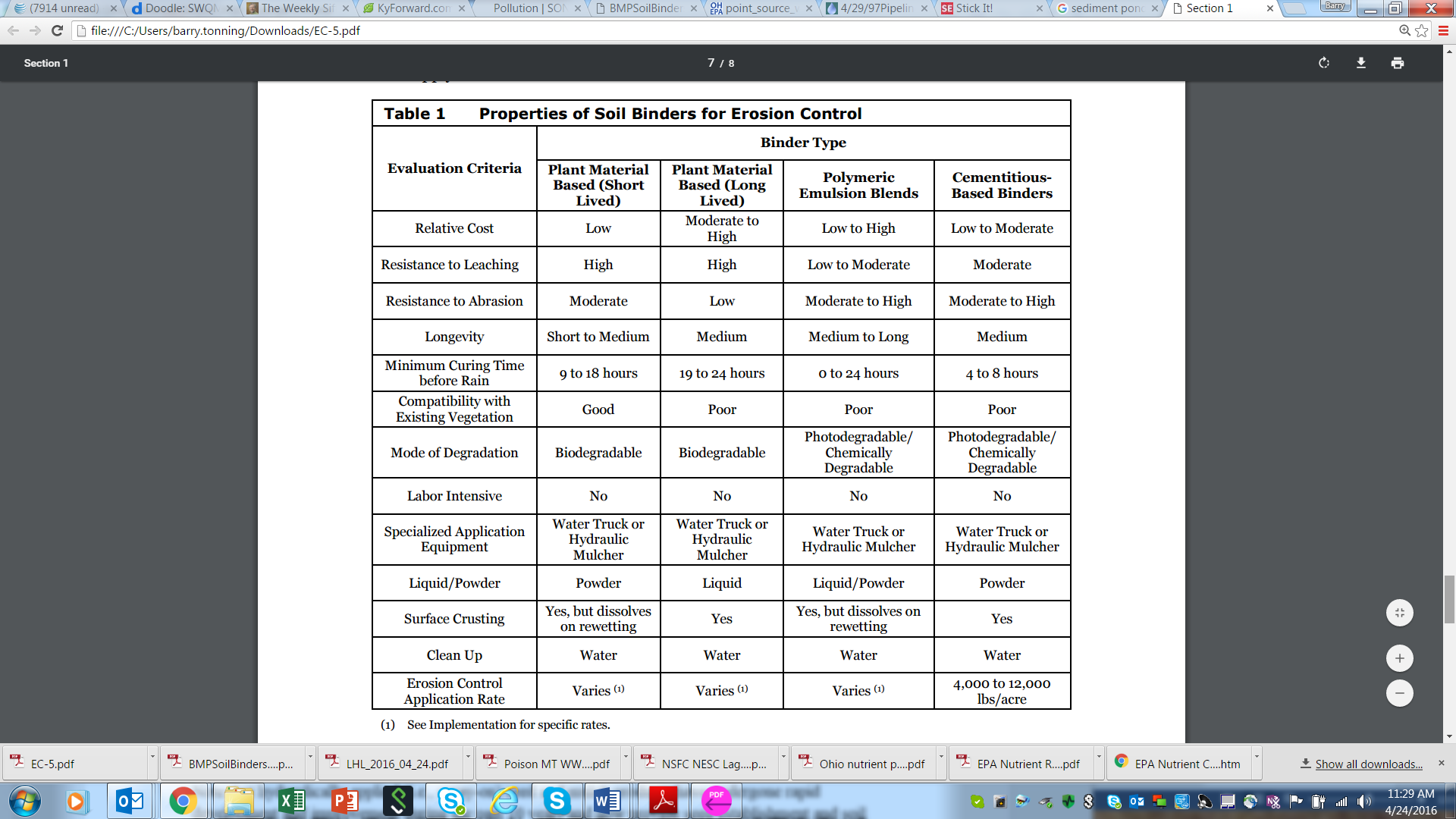
* Chloride compounds (calcium chloride, magnesium chloride, natural brines) have proven effective in controlling dust on roadways, but repeat applications are necessary and the product could restrict establishment of vegetation on treated areas due to chloride toxicity to plants.
* Organic, nonpetroleum-based chemicals such as calcium lignosulfonate and sodium lignosulfonate are also effective. All these chemicals work best on unpaved roadways with fines in the 10 percent to 30 percent range. Petroleum-based products are not recommended because of their adverse effects on plants and water resources.

## Design

Use of soil binders varies by site condition and product (see Table 3‑3 for example). Most hydraulically applied products function best when used on dry soil. Use a soil test to verify the exact type of soil at the site. When using a binder slurry or tackifier/mulch blend for seeding, leaving the top two inches of the surface loose helps to ensure good germination. If the soil is compacted, seeds won’t penetrate properly and the slurry will splatter and slide, resulting in uneven application.

Polymer tackifiers are generally applied at rates of 40 to 60 pounds per acre, and organic tackifiers are typically applied at rates of 80 to 120 pounds per acre; however, manufacturers’ recommendations vary and should be followed for both product types. Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch could be moved by wind or water. All other areas must have a uniform application of the tackifier.

Table 3‑3. Example properties of soil binders for erosion prevention (Source: CASQA 2012)



1. *Application rate varies with slope steepness (i.e., steeper = more); see manufacturer’s recommendation.*

Crown or slope the ground while grading to avoid ponding. Follow manufacturer's written recommendations for application rates, pre-wetting of application area (if necessary), and cleaning of equipment after use. Prior to application, roughen embankment and fill areas. Also, consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should not be applied during or immediately before rainfall. Avoid overspray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc. Spraying of hydraulic mulch should not be performed during windy conditions, which would prevent the proper placement. Do not apply to frozen soil, areas with standing water, under freezing or rainy conditions, or when the air temperature is below 40°F during the curing period. If more than one treatment is necessary, the second treatment may be diluted or have a lower application rate. Generally, soil binders require a minimum curing time of 24 hours before they are fully effective.

Additional important considerations for soil stabilizers include:

* When used alone, chemical stabilizers do not insulate the soil or retain moisture. Therefore, they do little to aid seedling establishment.
* They are easily damaged by traffic and lose their effectiveness more rapidly than organic mulches.
* They decompose with varying times, some within 60 to 90 days.
* Application of soil stabilizer is intended to be conducted with conventional hydraulic seeding equipment. Soil stabilizer may also be placed by dry spreading.
* When dry spreading is used, the contractor must ensure that the material is applied uniformly and remains in place during subsequent wind events.
* The manufacturer should provide detailed instructions on the storage, mixing and application procedures to insure proper safety and effectiveness of the product.
* Material safety data sheets should be provided to verify that products are free of toxics and to ensure proper handling.
* Seeding must be done in a manner that ensures direct contact with the soil.
* When using soil stabilizer, seed must be sown separately the soil stabilizer is applied.
* Application rates should be as recommended by the manufacturer.
* When soil stabilizer is used on permanent slopes, an approved mulch should be applied as well to protect and facilitate germination of new seed.

## Standards and Specifications

MnDOT Specification 2575.3 part E.1 (page 505) provides guidance for placing hydraulic erosion control products including tackifiers (natural and synthetic) and polyacrylamide. Part E.2 (page 505) covers soil stabilizer matrixes and application methods, rates, and timing. Specification 2575.4.G (pages 506, 507) covers measurement of hydraulic erosion control products. Hydraulic erosion control products should meet Specification 3884 (“Hydraulic Erosion Control Products”). The 2016 edition of the MnDOT *Standard Specifications for Construction* can be found here:

<http://www.dot.state.mn.us/pre-letting/spec/> (See <http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf>, page 505.)

## Inspection and Maintenance

Inspect the area before anticipated storm events (or series of storm events such as intermittent showers over one or more days), within 24 hours after the end of a rainfall event of one-half inch or more, and at least once every 14 calendar days. If possible, maintenance needs identified in inspections or by other means must be addressed before the next storm event, but in no case more than 7 days after the need is identified. If properly applied, little additional maintenance is required during the first weeks. After high winds or significant rainstorms, treated areas should be checked and re-treated if necessary.

Areas where erosion is evident should be repaired and treated again as soon as possible. Care is needed to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of treatment. In all cases, follow manufacturers’ recommendations regarding initial and follow-up application of hydraulically applied products. For example, some products require reapplication after specified time intervals and/or if treated areas become disturbed.

## Costs

The following table summarizes estimated BMP costs based on MnDOT data summarizing average bid prices for awarded projects in 2014.

Table 3‑4. Average Bid Prices (Based on Awarded Projects) for Spec Year 2014. Average price varies from year to year. Data for other years can be found on [MnDOT’s website](http://www.dot.state.mn.us/bidlet/average-bid-price.html). (Source: MnDOT)

| **Bid Item** | **Item Description** | **Units** | **Average Price** |
| --- | --- | --- | --- |
| 2575.561/00010 | Hydraulic Tackifier Type Natural | SY | $0.39 |

## Reference Materials

Except where more stringent requirements are presented in this guidance, BMPs shall comply with MnDOT and other state requirements. Primary design references include:

* MnDOT *Erosion Control Handbook II*

<http://www.dot.state.mn.us/environment/erosion/pdf/2006mndotecfieldhandbook.pdf>

* *Minnesota Urban Small Sites Best Management Practice Manual* (Mulches, Blankets and Mats)

<http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Resources-Management/Water-Quality-Management-Key-Roles.aspx>

* 2013 Minnesota NPDES/SDS Construction Stormwater General Permit <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/construction-stormwater/index.html>
* MnDOT *Standard Specifications for Construction* (2016 Edition)

<http://www.dot.state.mn.us/pre-letting/spec/>

* MnDOT Approved/Qualified Products for Hydraulic Erosion Control

<http://www.dot.state.mn.us/products/erosioncontrolandlandscaping/hydraulicerosioncontrol.html>

The following is a list of additional resources that are not specific to Minnesota:

* CASQA (California Stormwater Quality Association) *California Stormwater BMP Handbook* <http://prg.ocpublicworks.com/DocmgmtInternet/Download.aspx?id=717>
* Clark County Washington Stormwater Manual (BMP C121: Mulching)

<https://www.clark.wa.gov/environmental-services/stormwater-code-and-manual>

* *Clean Water Services Erosion Prevention and Sediment Control Manual* (4.1.4 Hydraulic Applications) <https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf>
* *North Carolina Erosion and Sediment Control Planning and Design Manual* (6.14 Mulching)

<https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>

* Tennessee Department of Environment and Conservation (TDEC) *Erosion and Sediment Control Handbook* (7.12 Hydro Applications, 7.13 Soil Binders) <http://tnepsc.org/handbook.asp>
* *Virginia Erosion and Sediment Control Handbook* (3.35 Mulching) <http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx>

# Erosion Control Blankets

## Definition

Erosion control blankets (ECBs) are typically biodegradable, open-weave blankets that provide temporary cover and support for establishing vegetation on bare soil areas.

## Purpose and Function

ECBs provide cover for bare soil and support for emergent vegetation (i.e., typically grass) from the time of seeding until root density and top growth are capable of long-term erosion protection. ECBs function by shielding bare soil and newly seeded areas against raindrop and wind erosion, providing a dense matrix of biodegradable material (e.g., straw, coconut) that stabilizes and supports emergent vegetation and later decomposes to further aid in plant growth. They also help to increase precipitation infiltration and decrease soil crusting and compaction. ECBs are designed and fabricated in a variety of types that last from a few months to approximately three years. Temporary ECBs are grouped into categories based on functional longevity and according to the Erosion Control Technology Council (see Table 4‑2) include:

Category 1: Ultra short-term – typically 3 months

Category 2: Short-term – typically 12 months

Category 3: Extended term – typically 24 months

Category 4: Long-term – typically 36 months

## Applicability

Degradable ECBs are appropriate for any bare soil area where temporary protection from raindrop and wind erosion is needed, or where newly seeded grass requires short-term cover and support prior to germination, early growth, and full establishment.

### 4.3.1 Site Applicability

ECBs are typically used where vegetation requires only temporary support for establishment, such as flat upland areas and slopes less than 4H:1V. They are also effective in establishing vegetation on relatively flat shoreline areas, swales, ditches, and athletic fields, or grassy areas that will be mowed closely such as places where longer term plastic netting may cause a tripping hazard or be pulled up later by equipment. ECBs can also be used as temporary cover for small bare areas that are idle for a few weeks (i.e., time periods too long to remain unprotected, but too short to seed). In these cases, blankets can be unrolled on bare portions of the site for a short period, removed when work commences, and reused.

Figure ‑. Erosion control blankets being installed along a steep slope

*Source: Barry Tonning, Tetra Tech*

ECBs can be especially useful for establishing permanent vegetation on slopes 2H:1V or greater (Figure 4‑1). They are generally effective for slopes up to 1.5H:1V, but may be used for slopes as steep as 1H:1V (see Table 4‑2 for example specifications). Manufacturer specifications should be consulted to verify that the selected ECB is appropriate for the site’s slope conditions.

### 4.3.2 Permit Applicability

The MPCA Construction General Permit has several requirements regarding temporary stabilization – which means that “the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring” ([Appendix B Section 26](http://stormwater.pca.state.mn.us/index.php/APPENDIX_B_-_DEFINITIONS)). In addition, ECBs generally meet the requirement that mulch materials “achieve approximately 90 percent ground coverage.”

ECBs provide a quick, effective, and economical approach for stabilizing areas that need very short-term protection – for a few weeks or months, where temporary seeding may not be warranted. [Part IV.B.2](http://stormwater.pca.state.mn.us/index.php/IV._CONSTRUCTION_ACTIVITY_REQUIREMENTS#IV.B_EROSION_PREVENTION_PRACTICES) of the MPCA Construction General Permit states that the permitte(s) “must stabilize all exposed soil areas (including stockpiles),” and notes that “(s)tabilization must be initiated immediately to limit soil erosion whenever any construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days.” In addition, the permit requires that “(s)tabilization must be completed no later than 14 calendar days after the construction activity in that portion of the site has temporarily or permanently ceased.”

Near public waters for which the Minnesota DNR has promulgated “work in water restrictions” during specified fish spawning time frames, all exposed soil areas that are within 200 feet of the water’s edge, and drain to these waters must complete the stabilization activities within 24 hours during the restriction period. Temporary stockpiles without significant silt, clay or organic components (e.g., clean aggregate stockpiles, demolition concrete stockpiles, sand stockpiles) and the constructed base components of roads, parking lots and similar surfaces are exempt from this requirement.

Other permit requirements exist during the construction of post-construction/permanent stormwater and temperature control BMPs discharging to special waters and impaired waters. In those cases, [Appendix A Section C.1](http://stormwater.pca.state.mn.us/index.php/APPENDIX_A) of the MPCA Construction General Permit requires that (s)tabilization of all exposed soil areas must be initiated immediately to limit soil erosion but in no case completed later than seven (7) days after the construction activity in that portion of the site has temporarily or permanently ceased.”

## Effectiveness

ECBs are effective in reducing rill, sheet, and wind erosion of bare soil on a range of situations, including slopes, swales, ditches, channels, and shore areas. Although their erosion reduction performance is generally 90 percent or more, their ultimate effectiveness is dependent upon the quality of surface preparation, installation methods (i.e., soil contact, staking pattern), and site conditions (e.g., slopes, soils, rainfall, etc.). Table 4‑1 summarizes expected performance for an array of typical water quantity and quality target constituents for erosion control blankets.

Table 4‑1. Expected performance for erosion control blankets

|  |  |
| --- | --- |
| **Water Quantity** | |
| Flow attenuation | ○ |
| Runoff volume reduction | ○ |
| **Water Quality** | |
| **Pollution prevention** | |
| Soil erosion | ● |
| Sediment control | ○ |
| Nutrient loading | ● |
| **Pollutant removal** | |
| Total suspended solids | ● |
| Total phosphorus | ● |
| Heavy metals | ◖ |
| Floatables | ○ |
| Oil and grease | ○ |

● Primary design benefit

◖ Secondary design benefit

○ Little or no design benefit

## Planning Considerations

Most ECB manufacturers readily provide information regarding their product’s performance, design specifications, slope/channel limits, longevity in the field (i.e., 3 months to 3 years), and other supporting data. ECBs should be selected based on site conditions. For example, products designed for flatter slopes will not perform adequately on steeper slopes, and using a blanket intended to last for three months on a slope where a full growing season is needed to establish dense vegetative cover will likely result in failure. Some higher longevity products may interfere with wildlife movement or habitat, the Minnesota DNR provides [additional information](http://files.dnr.state.mn.us/eco/nongame/wildlife-friendly-erosion-control.pdf) on wildlife-friendly erosion control.

The current list of MnDOT approved/qualified products for ECBs can be found on the MnDOT website: <http://www.dot.state.mn.us/products/erosioncontrolandlandscaping/erosioncontrolblankets2014.html>

ECBs should be installed as soon as possible after seeding is completed. Make sure all labor, tools, materials, and equipment (workers, blankets, stakes or staples, trencher, mallets, knives or shears, etc.) are on hand and ready when installation commences. Check site square footage vs. blanket coverage area to ensure sufficient blanket quantities. For long slopes, ensure equipment access to the top of the slope so that blankets can be unrolled from top to bottom. Try to complete installation over all seeded areas in one operation if possible. Divert upland runoff away from the seeded/blanketed area if possible.

## Design

ECBs are constructed of various degradable organic and/or synthetic materials (e.g., straw, wood excelsior, coconut, polypropylene) that are woven, glued or structurally bound with nettings or meshes. Components are stitched or glued together, or into/between biaxially oriented process nettings or woven natural fiber nettings. Alternations in the fiber, netting and bonding components can instill various degrees of blanket effectiveness, durability, and functional longevity. Blankets should be of uniform thickness, with the material fibers evenly distributed over the area of the blanket. The blankets should be porous enough to promote plant growth yet shield the underlying soil surface from erosion. All material should have been properly cured to achieve curled and barbed fibers, and blankets should be smolder resistant.



*Source: efficientservicesohio.com*

Figure 4‑2. Erosion control blanket made from straw

The net backing on each blanket should consist of cotton string or polypropylene mesh. For Category 1 blankets, the net backing should start to decompose after one month with 80 percent breakdown occurring within three months. For Category 2 and 3 blankets, the netting should contain sufficient UV stabilization for breakdown to occur within a normal growing season. For Category 4, the netting should be UV stabilized to provide a service life of two to three years. For blankets designated as “netting on two sides,” the fiber material should be sandwiched between a top and a bottom layer of net backing. The fiber material in each blanket should be securely attached to the net backing to prevent movement of the fiber.

The staples used to anchor Category 1 and 2 blankets should be U shaped, 11 gauge or heavier steel wire, having a span width of 1 inch and a length of 6 inches or more from top to bottom after bending. Staples used to anchor Category 3 and 4 blankets should have a minimum length of 8 inches. Wooden and other biodegradable stakes are recommended for areas where stray metal may cause problems. Spacing and patterns for staking vary according to each specific site – for example, closer staking patterns are required for steep slopes, ditches, channels, and shorelines. Regardless, all installations must meet or exceed minimum manufacturer’s requirements regarding slope/channel applications, staking patterns, and other factors to achieve their specified effectiveness.

To effectively install ECBs:

* Grade, clean, and seed the area first; install ECBs within 24 hours of seeding for best results.
* Anchor blanket at the top of the slope in a 6-inch slot on the contour, backfill, and compact.
* Install with netting on top, with majority of thread stitching on the bottom.
* Unroll from upslope to downslope, overlapping ends of the upslope roll at least 7 inches over the downslope roll. Overlap adjacent sides by at least 4 inches.
* Ensure blankets lie flat with good contact on the soil, with no bulges; do not stretch blankets.
* For channels, anchor blankets in a 6-inch backfilled slot at the top of the banks.
* Shingle and overlap edges parallel to the water flow by at least 4 inches.
* Overlap edges perpendicular to the water flow by at least 7 inches.
* For high velocity ditches and channels, space stakes at 1.5 feet below the waterline.
* Staple every 3 feet on flatter slopes, and every 2 feet below flow lines in ditches and channels.
* Use longer anchors in loose soil; use degradable stakes instead of metal staples near runways.
* For slopes steeper than 2H:1V and longer than 100 feet, and for ditches with slopes greater than 10H:1V, use 6 inch check slots every 100 feet on the contour / across the channel.

## Standards and Specifications

MnDOT Specification 2575.3 part G.2 (page 506) provides guidance for placement of erosion control blankets. Table 2575-2 summarizes requirements for stapling of blankets. Part K.2 (page 507, 508) covers maintenance of rolled erosion control products. Specification 2575.4.I (page 511) prescribes requirements for measurement of rolled erosion control products. ECBs should meet Specification 3885 (“Rolled Erosion Control Products”; page 679). Table 3885-1 summarizes acceptable types of rolled erosion control products. Tables 3885-2, 3885-3, and 3885-4 summarize physical requirements for rolled erosion control products by category. Table 3885-5 summarizes specifications for blanket anchors. The 2016 edition of the MnDOT *Standard Specifications for Construction* can be found here:

<http://www.dot.state.mn.us/pre-letting/spec/> (See <http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf>, pages 506 and 679.). Table 4‑2 provides example standard specifications for ECBs and mulch control nets.

Table 4‑2. Erosion Control Technology Council standard specifications for erosion control blankets and mulch control nets

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ULTRA SHORT-TERM - Typical 3 month functional longevity** | | | | | | |
| **Type** | **Product Description** | **Material Composition** | **Slope Applications\*** | | **Channel Applications\*** | **Minimum Tensile Strength 1** |
| **Maximum  Gradient** | **C**  **Factor 2, 5** | **Permissible Shear  Stresss3, 4, 6** |
| **1.A** | Mulch Control Nets | A photodegradable synthetic mesh or woven biodegradable natural fiber netting. | 5:1 (H:V) | < 0.10 @ 5:1 | = 0.25 lbs/ft2 (12 Pa) | 5 lbs/ft (0.073 kN/m) |
| **1.B** | Netless Rolled Erosion  Control Blankets | Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP. | 4:1 (H:V) | < 0.10 @ 4:1 | = 0.5 lbs/ft2 (24 Pa) | 5 lbs/ft (0.073 kN/m) |
| **1.C** | Single-net Erosion Control Blankets & Open Weave Textiles | Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly degrading, synthetic or natural fiber netting or an open weave textile of processed rapidly degrading natural or polymer yarns or twines woven into a continuous matrix. | 3:1 (H:V) | < 0.15 @ 3:1 | = 1.5 lbs/ft2 (72 Pa) | 50 lbs/ft (0.73 kN/m) |
| **1.D** | Double-net Erosion Control Blankets | Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings. | 2:1 (H:V) | < 0.20 @ 2:1 | = 1.75 lbs/ft2 (84 Pa) | 75 lbs/ft (1.09 kN/m) |
| **SHORT-TERM - Typical 12 month functional longevity** | | | | | | |
| **2.A** | Mulch Control Nets | A photodegradable synthetic mesh or woven biodegradable natural fiber netting. | 5:1 (H:V) | < 0.10 @ 5:1 | = 0.25 lbs/ft2 (12 Pa) | 5 lbs/ft (0.073 kN/m) |
| **2.B** | Netless Rolled Erosion  Control Blankets | Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP. | 4:1 (H:V) | < 0.10 @ 4:1 | = 0.5 lbs/ft2 (24 Pa) | 5 lbs/ft (0.073 kN/m) |
| **2.C** | Single-net Erosion Control Blankets & Open Weave Textiles | An erosion control blanket composed of processed degradable natural or polymer fibers mechanically bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix or an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix. | 3:1 (H:V) | < 0.15 @ 3:1 | = 1.5 lbs/ft2 (72 Pa) | 50 lbs/ft (0.73 kN/m) |
| **2.D** | Double net Erosion Control Blankets | Processed degradable natural and/or polymer fibers mechanically bound together between two degradable, synthetic or natural fiber nettings. | 2:1 (H:V) | < 0.20 @ 2:1 | = 1.75 lbs/ft2 (84 Pa) | 75 lbs/ft (1.09 kN/m) |
| **EXTENDED-TERM - Typical 24 month functional longevity** | | | | | | |
| **3.A** | Mulch Control Nets | A slow degrading synthetic mesh or woven natural fiber netting. | 5:1 (H:V) | < 0.10 @ 5:1 | = 0.25 lbs/ft2 (12 Pa) | 25 lbs/ft (0.36 kN/m) |
| **3.B** | Erosion Control Blankets & Open Weave Textiles | An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix. | 1.5:1 (H:V) | < 0.25 @ 1.5:1 | = 2.00 lbs/ft2 (96 Pa) | 100 lbs/ft (1.45 kN/m) |
| **LONG-TERM - Typical 36 month functional longevity** | | | | | | |
| **4** | Erosion Control Blankets & Open Weave Textiles | An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix. | 1:1 (H:V) | < 0.25 @ 1:1 | = 2.25 lbs/ft2 (108 Pa) | 125 lbs/ft (1.82 kN/m) |

*Source: Erosion Control Technology Council, 2003.*

*Notes: \* C factor and shear stress for Types 1.A., 2.A. and 3.A mulch control nettings must be obtained with netting used in conjunction with preapplied mulch material.*

*1 Minimum Average Roll**Values when tested in the machine direction using ECTC Modified ASTM D 5035.*

*2 C Factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, h:v) to ratio of soil loss from unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions using ECTC Test Method # 2.*

*3 Minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion [> 12.7 mm(0.5 in) soil loss] during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method #3.*

*4 The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 - 0.05.*

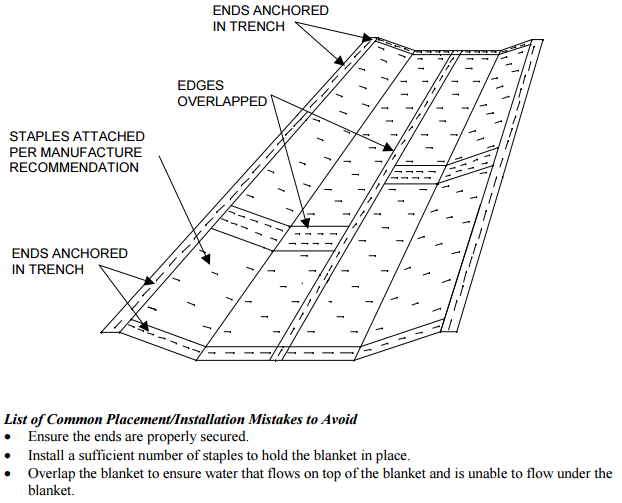
*5 Acceptable large-scale test methods may include ASTM D6459 or other independent testing deemed acceptable by the engineer.*

*6 Acceptable large-scale testing protocol may include ASTM D6460 or other independent testing deemed acceptable by the engineer.*

## Inspection and Maintenance

Inspect the ECB installation site immediately after seeding to verify seed coverage. Site must be relatively smooth and free of rocks larger than 2 inches, sticks, protruding roots, clumps of vegetation, trash, and debris. Inspect the ECB after installation, checking staking patterns, anchor slot backfill, soil contact, overlaps, and proper shingling (i.e., upslope ECB edges lap over the downslope blanket edge). Pay particular attention to installations on long steep slopes and below the waterline in ditches and channels.

Flag off the area after installation to keep equipment, vehicles, and foot traffic off ECBs. Inspect ECBs weekly after installation, and within 24 hours after each rainfall of ½ inch or more. Look for “pulls” or sags on steep slopes, where the weight of precipitation clinging to the ECB is pulling the blanket downhill, away from its anchor slot(s) and staples. Check for areas where overlaps are pulled apart, or become flipped up by runoff or animals. If protected species of animals are present, look for areas where burrowing or crawling animals may be trapped by higher longevity blankets. The figure below illustrates the proper installation technique for ECBs and common installation mistakes.



*Source: North Dakota Division of Water Quality*

Figure 4‑3. Proper installation of erosion control blanket

ECBs should be maintained until vegetation is established. It may be necessary to irrigate blankets and underlying seed during long dry periods to ensure seed germination and growth. Use at least 3,000 gallons per acre, and apply irrigation water during cloudy periods or in the evening, if possible, to avoid excessive evaporation.

If bulges appear due to emerging seedlings pushing the blanket off the ground, the problem is likely a result of improper staking or stapling. Install additional stakes 1.5 feet apart in the bulge areas as soon as possible so that the grass can find its way through the blanket.

If sagging occurs, install longer anchors on a closer pattern as soon as possible. Use scissors or shears to cut out bulges or large sags, then stake the area securely. If necessary, use hand scattered straw and mulch control netting for spot repairs.

Where animal species are being trapped or hindered by higher longevity blankets, consider using a shorter-term blanket and replacing it after a few months, if necessary. Otherwise, replace the ECB in the problem area(s) with sod, straw, or hydromulch.

MnDOT’s workmanship and rework schedule (2016; version under development at the time of manual update) identifies common deficiencies for various types of stabilization BMPs – including ECBs – and corrective actions for these deficiencies. Once complete, the full, final version of this table will replace Table 2575-4 in [MnDOT *Standard Specifications for Construction*](http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf)(2016 edition).

Table 4‑3. Excerpt from Table 2575-4, Required Corrective Action

|  |  |  |
| --- | --- | --- |
| **Item** | **Corrective Action Required if:** | **Corrective action** |
| Erosion control blankets and mats | Upgrade ends not embedded or surface bonded on slopes  Improper overlaps and joints  Insufficient number of staples  Improper stapling pattern  No embedment of joints in drainage ways | Properly imbed or bond blanket  Provide proper joints and overlaps  Provide for the additional required staples  Staple at proper patterns  Embed joints properly |

## Costs

The following table summarizes estimated BMP costs based on MnDOT data summarizing average bid prices for awarded projects in 2014.

Table 4‑4. Average Bid Prices (Based on Awarded Projects) for Spec Year 2014. Average price varies from year to year. Data for other years can be found on [MnDOT’s website](http://www.dot.state.mn.us/bidlet/average-bid-price.html). (Source: MnDOT)

| **Bid Item** | **Item Description** | **Units** | **Average Price** |
| --- | --- | --- | --- |
| 2575.523/00009 | Erosion Control Blankets Category 0 | SY | $2.39 |
| 2575.523/00011 | Erosion Control Blankets Category 1 | SY | $1.31 |
| 2575.523/00012 | Erosion Control Blankets Category 2 | SY | $1.02 |
| 2575.523/00013 | Erosion Control Blankets Category 3 | SY | $1.50 |
| 2575.523/00014 | Erosion Control Blankets Category 4 | SY | $1.75 |
| 2575.523/00015 | Erosion Control Blankets Category 5 | SY | $1.65 |
| 2575.523/00016 | Erosion Control Blankets Category 6 | SY | $2.90 |
| 2575.519/00010 | Disk Anchoring | acre | $94.65 |

## Reference Materials

Except where more stringent requirements are presented in this guidance, BMPs shall comply with MnDOT and other state requirements. Primary design references include:

* MnDOT *Erosion Control Handbook II*

<http://www.dot.state.mn.us/environment/erosion/pdf/2006mndotecfieldhandbook.pdf>

* *Minnesota Urban Small Sites Best Management Practice Manual* (Mulches, Blankets and Mats)

<http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Resources-Management/Water-Quality-Management-Key-Roles.aspx>

* 2013 Minnesota NPDES/SDS Construction Stormwater General Permit

<http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/construction-stormwater/index.html>

* MnDOT *Standard Specifications for Construction* (2016 Edition)

<http://www.dot.state.mn.us/pre-letting/spec/>

The following is a list of additional resources that are not specific to Minnesota:

* Clark County Washington Stormwater Manual (BMP C122: Nets and Blankets)

<https://www.clark.wa.gov/environmental-services/stormwater-code-and-manual>

* *Clean Water Services Erosion Prevention and Sediment Control Manual* (4.1.3 Ground Cover, 4.1.5 Matting) <https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf>
* Kentucky Division of Water *Best Management Practices (BMPs) for Controlling Erosion, Sediment, and Pollutant Runoff from Construction Sites – Planning and Technical Specifications Manual* <http://transportation.ky.gov/Stormwater/Pages/Construction-Development-Community-ResourcesGuidance.aspx>
* *North Carolina Erosion and Sediment Control Planning and Design Manual* (6.17 Rolled Erosion Control Products, 6.18 Compost Blankets)

<https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>

* Tennessee Department of Environment and Conservation (TDEC) *Erosion and Sediment Control Handbook* (7.11 Rolled Erosion Control Products) <http://tnepsc.org/handbook.asp>
* *Virginia Erosion and Sediment Control Handbook* (3.36 Soil Stabilization Blankets and Matting) <http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx>
* United States Department of Agriculture – Forest Service. *Erosion Control Treatment Selection Guide*. <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0677%201203P>

# Turf Reinforcement Mats

## Definition

Turf reinforcement mats (TRMs) are synthetic, non-degradable soil and seedbed covers of variable thickness designed to provide short-term protection against raindrop and wind erosion, permanent support for vegetation on slopes, and permanent armoring and vegetation support for ditches, swales, and channels. They are composed of UV stabilized, synthetic fibers, filaments, nettings and/or wire mesh that are processed into three dimensional reinforcement matrices – a design that serves permanent and critical applications where site conditions exceed the limits of mature natural vegetation. TRMs provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. TRM manufactures are also providing flexible growth media integrated into the mat.

## 5.2 Purpose and Function

TRMs, like erosion control blankets, are part of the larger group of rolled erosion control products. TRMs are used to provide temporary cover for bare soil, long-term support for vegetation, and permanent armoring against shear stress caused by flowing water. TRMs share many attributes with erosion control blankets, but are non-degradable, erosion protection aids. After installation, vegetation and soil provide shielding from the sun and the elements, preserving the synthetic components and maintaining the structural integrity of TRMs.

## 5.3 Applicability

TRMs can be used to prevent erosion and support vegetation on a wide variety of site slope and drainage features. They are typically used in conjunction with grass and other seed on steep slopes, in higher velocity ditches and channels, along shorelines, and for scour prevention and armoring at culvert outlets. Some of the thinner TRMs are designed to be placed directly over seeded bare soil areas, while some thicker open-celled/open weave products may be staked down first, then seeded, and then covered with a thin layer of topsoil. Because of the many different types of products, manufacturer’s specifications regarding use, installation, anchoring device selection, and maintenance must be followed precisely.

### 5.3.1 Site Applicability

TRMs are used to support permanent vegetation on longer, steeper slopes (e.g., more than 100 feet and 3H:1V) and in steeper, higher velocity ditches and channels (e.g., more than 10H:1V; velocities of up to 15 feet per second, and shear stress of up to 10 lbs per square foot). They are typically used when slope and channel conditions exceed the capabilities (e.g., manufacturer’s requirements) of erosion control blankets, but are not severe enough to justify terracing or retaining walls in slope applications, or harder armoring (e.g., articulated block, riprap, pavement, etc.) within channels.

### 5.3.2 Permit Applicability

As noted above, TRMs provide permanent support for vegetation on slopes, and permanent armoring for vegetated ditches, swales, and channels. They also provide protection against raindrop and wind erosion during the weeks between seeding and plant emergence. As such, TRMs are an integral part of the site’s permanent cover, which is defined in Appendix B of the MPCA Construction General Permit as “surface types that will prevent soil failure under erosive conditions.” The permit defines a uniform perennial vegetative cover as “evenly distributed, without large bare areas” and “with a density of 70 percent of the native background vegetative cover for the area,” which “must be established on all unpaved areas and areas not covered by permanent structures” in order to terminate permit coverage.

Besides supporting vegetation on bare areas and in ditches, TRMs are often used to construct permanent stormwater management systems, which are addressed in Part III.D of the MPCA permit. Components of permanent stormwater management systems that may be supported by TRMs include infiltration areas, vegetated ditches/channels, sedimentation basins, regional ponds, and vegetated buffers adjacent to surface waters. TRMs are extremely useful in ditch and channel stabilization that are required for certain areas by Part IV.B.4 of the permit, which states that the permittee “must stabilize the normal wetted perimeter of any temporary or permanent drainage ditch or swale that drains water from any portion of the construction site, or diverts water around the site, within 200 lineal feet from the property edge, or from the point of discharge into any surface water. Stabilization of the last 200 lineal feet must be completed within 24 hours after connecting to a surface water or property edge.”

For general site stabilization, Part IV.B.2 of the MPCA Construction General Permit requires that the permitte(s) “must stabilize all exposed soil areas (including stockpiles),” and notes that “(s)tabilization must be initiated immediately to limit soil erosion whenever any construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days.” In addition, the permit requires that “(s)tabilization must be completed no later than 14 calendar days after the construction activity in that portion of the site has temporarily or permanently ceased.”

## 5.4 Effectiveness

When selected, sited, installed, and maintained properly, TRMs are effective in providing short-term protection against raindrop and wind erosion, permanent support for vegetation on slopes, and permanent armoring for vegetated ditches, swales, and channels. They generally reduce sheet, rill, and channel erosion by 90 percent or more. Effectiveness is dependent upon TRM type, surface preparation, installation practices (i.e., soil contact, staking pattern, seeding, etc.), and site conditions (e.g., slopes, soils, rainfall, etc.). Mowing vegetation over TRMs too low after installation (i.e., to the point where the TRM is exposed to sunlight) can reduce TRM effectiveness significantly over the long term and should be avoided. Table 5‑1 summarizes expected performance for an array of typical water quantity and quality target constituents for TRMs.

Table 5‑1. Expected performance for turf reinforcement mats

|  |  |
| --- | --- |
| **Water Quantity** | |
| Flow attenuation | ○ |
| Runoff volume reduction | ○ |
| **Water Quality** | |
| **Pollution prevention** | |
| Soil erosion | ● |
| Sediment control | ○ |
| Nutrient loading | ● |
| **Pollutant removal** | |
| Total suspended solids | ● |
| Total phosphorus | ● |
| Heavy metals | ◖ |
| Floatables | ○ |
| Oil and grease | ○ |

● Primary design benefit

◖ Secondary design benefit

○ Little or no design benefit

## 5.5 Planning Considerations

TRMs are designed and fabricated to address specific site conditions, such as slope range and length, water velocity, and shear stress, UV exposure, seed type, and post-installation soil fill (see Table 5‑2 for example specifications). As such, it is critical to observe the manufacturer’s requirements when selecting, siting, installing, and maintaining a TRM to achieve optimal performance. For example, TRM installation procedures may include applying the mat over bare seeded ground, or installing the TRM over the bare ground first followed by seed application and a topsoil cover over the TRM. Some applications specify for the seed to be mixed with the fill soil prior to spreading. In cases where a TRM is installed prior to seeding and backfilling with soil, some applications may require the installation of an erosion control blanket to protect the seed and soil within the three-dimensional matrix of the mat during the time between seeding and establishment of dense growth.

Regardless of the order required for mat installation, seeding, and topsoil cover, the need for proper preparation of the bare soil area or channel remains constant:

* Plan final surface preparation, seeding, and mat installation during dry periods.
* Assemble mats, anchors, dry topsoil cover, seed, and other needed materials.
* Establish final grade for the ditch, channel, swale, or bare ground to be seeded and protected.
* Test soil and adjust pH and fertility according to seed needs; avoid fertilizing ditches/channels.
* Remove all rocks larger than 2 inches and all sticks, limbs, protruding roots, and other debris.
* Ensure all surfaces are smooth and consistent, with a crumbly texture; rake rough spots as needed.
* Install seed, TRM, anchors, and top dressing of fill soil as directed by manufacturer’s instructions.
* Note requirements for using check slots to anchor top-of-slope and in-channel applications.

The current list of MnDOT approved/qualified products for TRMs can be found on the MnDOT website: <http://www.dot.state.mn.us/products/erosioncontrolandlandscaping/turf-mats.html>

## 5.6 Design

TRMs are synthetic, non-degradable mats that are typically buried to add stability to soils. They come in a wide range of designs and are valuable soil stabilizers on slope and channel-lining applications. TRMs are designed to be permanent and often are filled with soil and vegetated when installed. A TRM may have a biodegradable component intermixed with the synthetic portion to aid plant establishment.

Mats should be selected for the expected velocity and shear stress. TRMs with non-degrading, three-dimensional matrices can withstand velocities and shear stress values up to 15 feet per second and 10 lb per square foot, respectively. However, beyond these thresholds, vegetated structures such as articulated block, cable concrete, and cribwalls should be considered. Required minimum thickness and area holding capacity of the TRM should be defined by the manufacturer.

Once finish grade is established, the area should be seeded, the TRM installed and, if appropriate, immediately filled with topsoil. The finish surface is normally seeded and covered with an erosion control blanket or hydraulically applied mulch to keep the soil from eroding and aid in germination of a permanent stand of vegetation. Manufacturer’s recommendations should be followed for specific applications.

Some TRMs contain supplemental degradable components; all have a permanent three-dimensional structure with high tensile strength that functions as a matrix for securing plant roots, stems, and soils. TRMs and their constituent vegetation form a continuous composite, which becomes a unified, living mat. The resulting synergism increases root system lateral strength, reducing plant dislodgement under high velocity, high shear stress flows. The TRM’s permanent structure also consolidates and protects the soil in which the plants are anchored, preventing it from being stripped out of the vegetative cover and thus weakening root support.

TRMs are often employed as a “green” alternative to stone riprap, pavement, and other forms of hard armoring. They are typically used in a manner that optimizes plant root interaction with the mat structure. Typical installations involve rolling out and anchoring the TRM in intimate contact with the soil surface.

There are two general methods of TRM installation, depending upon the type of mat used. One method involves directly applying the TRM over a freshly seeded soil surface to allow vegetation to develop upwards through the mat structure. In this scenario, the TRM initially acts to prevent both erosion of the soil’s plant root structure and dislodgement of individual plants from the soil surface. As natural sedimentation processes eventually fill the spaces in the mat, successive stands of vegetation can grow down into and/or through the underlying mat structure for long-term root reinforcement.

The second method for installing TRMs is to first unroll the product, then cover with a mix of fine soil and the prescribed seed mix. In this type of installation, the vegetation immediately roots down into and/or through the matting structure for both immediate and permanent reinforcement.

Specific installation instructions after surface preparation include:

* Seed bare area, if called for by manufacturer’s instructions.
* Unroll from upslope to downslope, overlapping ends of the upslope roll at least 7 inches over the downslope roll. Overlap adjacent sides by at least 4 inches.
* Ensure mats lie flat with good contact on the soil and no bulges; do not stretch TRMs.
* For channels, anchor mats in a 6-inch backfilled slot at the top of the banks.
* Shingle and overlap edges parallel to the water flow by at least 4 inches.
* Overlap edges perpendicular to the water flow by at least 7 inches.
* Use only anchors specified by manufacturer’s instructions.
* For high velocity ditches and channels, space anchors at 1.5 feet below the waterline.
* Anchor every 3 feet on slopes, and every 2 feet below flow lines in ditches and channels.
* Use longer anchors in loose soil; use degradable stakes instead of metal staples near runways.
* For slopes steeper than 2H:1V and longer than 100 feet, and for ditches with slopes greater than 10H:1V, use 6 inch check slots every 100 feet on the contour / across the channel.
* Spread seed and/or seed and soil mix over installed mat, if applicable.

If soil cover is applied, use a sandy clay loam, topsoil, or other appropriate media as directed by the manufacturer’s instructions. Use only dry soil, which can be spread easily. Using a flat tool or the backside of a rake, lightly spread no more than ½ to ¾ inch of soil onto the mat, completely filling the voids. If equipment must operate on the mat, use rubber-tired types only (i.e., no treaded or tracked equipment). Do not make sharp turns and avoid rapid movements that cause the mat to bunch up. Keep equipment off mats if the soil is wet. Apply the soil cover until only the top of the mat is exposed – do not cover mat completely. Broadcast additional seed and apply a degradable erosion control blanket over the soil-filled blanket if required.

U-shaped wire staples or metal geotextile pins can be used to anchor mats to the ground surface. Wire staples should be 8 gauge or thicker; metal pins should be at least 0.2 inches diameter steel with a 1.2 inch stall washer. Degradable stakes can be used on flatter areas, and where metal or other anchor types might pose problems if accidently dislodged (e.g., near airport runways). Otherwise wire staples, metal pins with washers, or percussion driven anchors are recommended for slopes, bank areas, and channel applications. Use 6-inch anchors for rocky or clayey soils, 12-inch anchors for looser clays and silty soils, and 18- or 24-inch anchors for sandy silts and loose sands. Follow the manufacturer’s instructions for anchor spacing and configuration, with at least one anchor per square yard on flatter ground, 2 anchors per square yard on steep slopes, and 3 anchors per square yard in channels and on shorelines. Drive anchors in until they are flush with the top of the mat – do not countersink or bury.

Table 5‑2. Erosion Control Technology Council standard specifications for permanent turf reinforcement mats

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Type1** | **Product Description** | **Material Composition** | **Minimum Tensile Strength2,3** | **Minimum Thickness**  (ASTM D 6525) | **UV Stability**  (ASTM D 4355 @ 500 Hours) | **Channel Applications**  Permissible Shear Stress4, 5 |
| 5.A | Turf Reinforcement Mat | Long term, non-degradable rolled erosion control product composed of UV stabilized, non-degradable, synthetic fibers, filaments, nettings and/or wire mesh processed into three dimensional reinforcement matrices designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation. Turf reinforcement mats provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. | 125 lbs/ft  (1.82 kN/m) | 0.25 inches  (6.35 mm) | 80% | = 6.0 lbs/ft2 (288 Pa) |
| 5.B | Turf Reinforcement Mat | 150 lbs/ft  (2.19 kN/m) | 0.25 inches  (6.35 mm) | 80% | = 8.0 lbs/ft2 (384 Pa) |
| 5.C | Turf Reinforcement Mat | 175 lbs/ft  (2.55 kN/m) | 0.25 inches  (6.35 mm) | 80% | = 10.0 lbs/ft2 (480 Pa) |

*Source: Erosion Control Technology Council, 2003.*

Notes:

*1 For applications in channels and on slopes not exceeding 0.5:1 (H:V) where vegetation alone will not sustain expected flow conditions and/or provide sufficient long-term erosion protection. For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.*

*2 Minimum Average Roll Values, machine direction only for tensile strength determination using ASTM D6818 (Supersedes Mod. ASTM D5035 for RECPs)*

*3 Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 44 kN/m (3,000 lb/ft) or greater.*

*4 Shear stress that fully vegetated TRM can sustain without physical damage or excess erosion [> 12.7 mm (0.5 in.) soil loss] during a 30-minute flow event in large scale testing.*

1. *Acceptable large-scale testing protocol may include ASTM D6460 or other independent testing deemed acceptable by the engineer.*

## 5.7 Standards and Specifications

MnDOT Specification 2575.3 part G.3 (page 507) provides guidance for placement of TRMs. Part K.2 (page 507, 508) covers maintenance of rolled erosion control products. Specification 2575.4.I (page 511) prescribes requirements for measurement of rolled erosion control products. TRMs should meet Specification 3885 (“Rolled Erosion Control Products”). Table 3885-6 (Section 3885.2.B.5, page 682) summarizes TRM criteria. The 2016 edition of the MnDOT *Standard Specifications for Construction* can be found here: <http://www.dot.state.mn.us/pre-letting/spec/> (See <http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf>, pages 507 and 682.)

## 5.8 Inspection and Maintenance

Inspect the TRM installation site immediately after seeding (if applicable) to verify seed coverage. The site must be relatively smooth and free of rocks larger than 2 inches, sticks, protruding roots, clumps of vegetation, trash, and other debris. Inspect the TRM after installation, checking staking patterns, anchor slot backfill, soil contact, overlaps, and proper shingling (i.e., upslope TRM edges lap over the downslope mat edge). Pay particular attention to installations on long steep slopes and below the waterline in ditches and channels.

Flag off the area after installation to keep equipment, vehicles, and foot traffic off TRMs. After installation, inspect weekly and within 24 hours after each rainfall of ½ inch or more. Look for “pulls” or sags on steep slopes where the weight of precipitation clinging to the mat has pulled it downhill away from its anchor slot(s) and staples. Check for areas where overlaps are pulled apart, or being flipped up by runoff or animals.

Do not mow TRM areas until vegetation is at least 8 inches tall and dense. Mower blades must be kept 6 inches off the mat to prevent snagging and pulling. Seed areas of sparse vegetation and cover with ½ inch of soil and a fitted piece of TRM. If mat sagging occurs, install longer anchors on a closer pattern as soon as possible. Use scissors or shears to cut out bulges or large sags, and stake the area securely. Replace missing or damaged sections of the mat per the original installation guidelines. Repair small holes or rips with patches of the original mat type if possible. Cut out damaged, bulged, or upturned sections with a knife or shears, and use soil, seed, TRM, and ECB if necessary to restore and dress up the damaged area. Use ties to attach the new mat section to the existing TRM.

Remove deposits of sediment and debris carefully to avoid damage to the mat. When excavation is needed within 12 inches of the mat, remove sediment and/or debris by hand or with a visual spotter. If equipment must operate on the mat, make sure it is of the rubber-tired type. No tracked equipment or sharp turns are allowed on the mat. Where protected animal species are being trapped or hindered by TRMs, consider cutting out small sections to create escape portals and reinforcing the surrounding area with sod.

MnDOT’s workmanship and rework schedule (2016; version under development at the time of manual update) identifies common deficiencies for various types of stabilization BMPs – including TRMs – and corrective actions for these deficiencies. Once complete, the full, final version of this table will replace Table 2575-4 in [MnDOT *Standard Specifications for Construction*](http://www.dot.state.mn.us/pre-letting/spec/2016/2016specbook.pdf)(2016 edition).

Table 5‑3. Excerpt from Table 2575-4, Required Corrective Action

|  |  |  |
| --- | --- | --- |
| **Item** | **Corrective Action Required if:** | **Corrective Action** |
| Turf Reinforcement Mat | Wrong TRM installed  Missing certificate of compliance  Missing anchoring devices  Insufficient anchoring devices  Missing head anchor embedment  Missing edge anchor embedment  Improper or insufficient overlap of adjoining mat units  Improper soil infill depth (about 1 inch)  Improper soil type  Improper hydraulic mulch RFM infill  Wrong rolled erosion control cover | Remove incorrect and replace with proper TRM  Cease operations and secure certificate. Else remove and replace  Install additional anchoring devices as per plan or Manufacturer  Install additional anchoring devices as per plan or Manufacturer  Entrench leading edge and anchor correctly  Entrench side edge and anchor correctly  Provide proper joints and overlaps  Apply additional screen topsoil or screed excess  Cease operations and contact OES  Apply additional hydraulic mulch Type RFM to manufacturer specification  Remove improper RECP and apply correct product |

## 5.10 Costs

The following table summarizes estimated BMP costs based on MnDOT data summarizing average bid prices for awarded projects in 2014.

Table 5‑4. Average Bid Prices (Based on Awarded Projects) for Spec Year 2014. Average price varies from year to year. Data for other years can be found on [MnDOT’s website](http://www.dot.state.mn.us/bidlet/average-bid-price.html). (Source: [MnDOT](http://www.dot.state.mn.us/bidlet/average-bid-price.html))

| **Bid Item** | **Item Description** | **Units** | **Average Price** |
| --- | --- | --- | --- |
| 2575.525/00020 | Turf Reinforcement Mat Category 2 | SY | $15.91 |
| 2575.525/00030 | Turf Reinforcement Mat Category 3 | SY | $3.34 |
| 2575.525/00040 | Turf Reinforcement Mat Category 4 | SY | $13.59 |

## 5.11 Reference Materials

Except where more stringent requirements are presented in this guidance, BMPs shall comply with MnDOT and other state requirements. Primary design references include:

* MnDOT *Erosion Control Handbook II* <http://www.dot.state.mn.us/environment/erosion/pdf/2006mndotecfieldhandbook.pdf>
* *Minnesota Urban Small Sites Best Management Practice Manual* (Mulches, Blankets and Mats)

<http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Resources-Management/Water-Quality-Management-Key-Roles.aspx>

* 2013 Minnesota NPDES/SDS Construction Stormwater General Permit

<http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/construction-stormwater/index.html>

* MnDOT *Standard Specifications for Construction* (2016 Edition) <http://www.dot.state.mn.us/pre-letting/spec/>

The following is a list of additional resources that are not specific to Minnesota:

* *Clean Water Services Erosion Prevention and Sediment Control Manual* (44.1.5 Matting)

<https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf>

* *North Carolina Erosion and Sediment Control Planning and Design Manual* (6.17 Rolled Erosion Control Products)

<https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual>

* Kentucky Division of Water *Best Management Practices (BMPs) for Controlling Erosion, Sediment, and Pollutant Runoff from Construction Sites – Planning and Technical Specifications Manual* [http://transportation.ky.gov/Stormwater/Pages/Construction-Development-Community-ResourcesGuidance.aspx](http://transportation.ky.gov/Stormwater/Pages/Construction-Development-Community-ResourcesGuidance.aspx%20)
* Tennessee Department of Environment and Conservation (TDEC) *Erosion and Sediment Control Handbook* (7.11 Rolled Erosion Control Products) <http://tnepsc.org/handbook.asp>
* *Virginia Erosion and Sediment Control Handbook* (3.36 Soil Stabilization Blankets and Matting) <http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx>
* Clark County Washington Stormwater Manual (BMP C122: Nets and Blankets)

<https://www.clark.wa.gov/environmental-services/stormwater-code-and-manual>

* U.S. EPA. 1999. [Storm Water Technology Fact Sheet, Turf Reinforced Mats](https://nepis.epa.gov/Exe/ZyNET.exe/2000449O.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1995+Thru+1999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A\zyfiles\Index%20Data\95thru99\Txt\00000015\2000449O.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h|-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL).